December 26, 1960

Aviation Week and Space Technology

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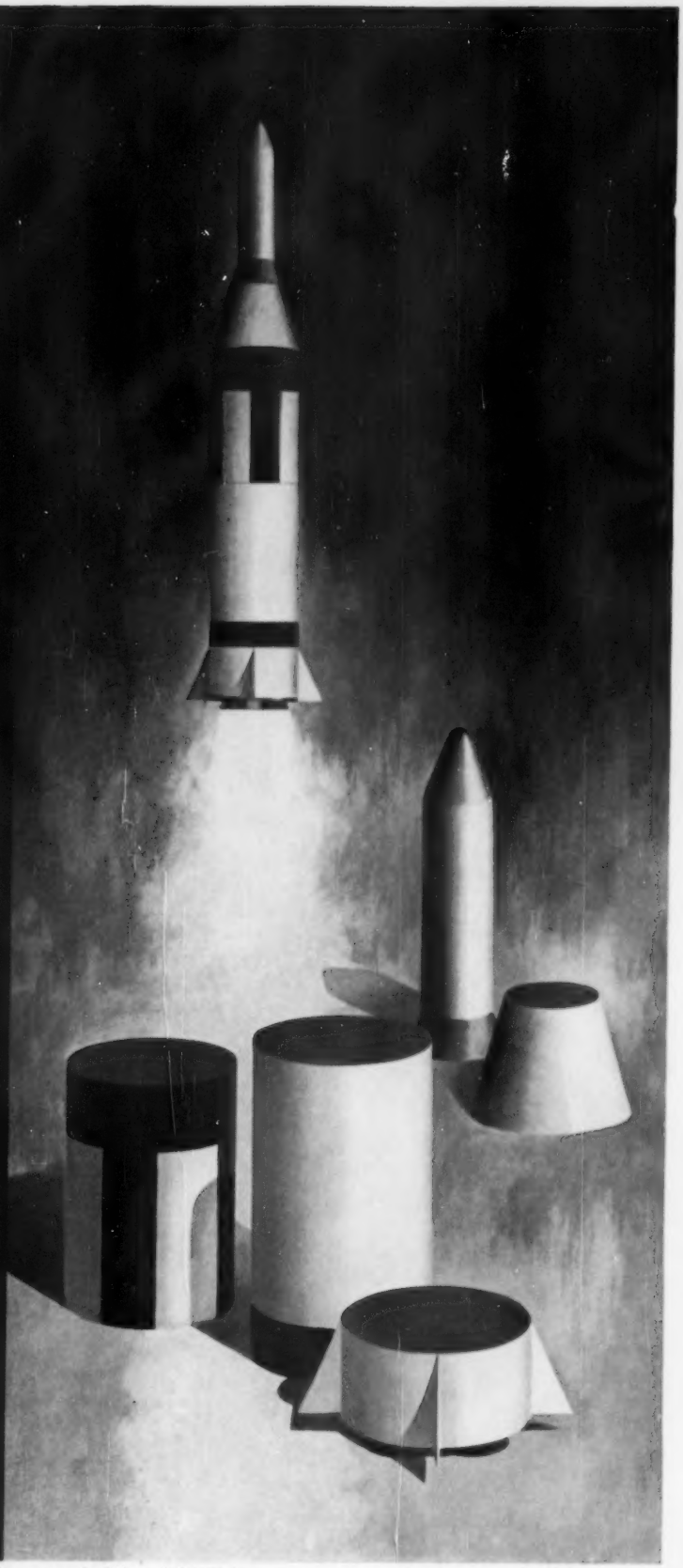

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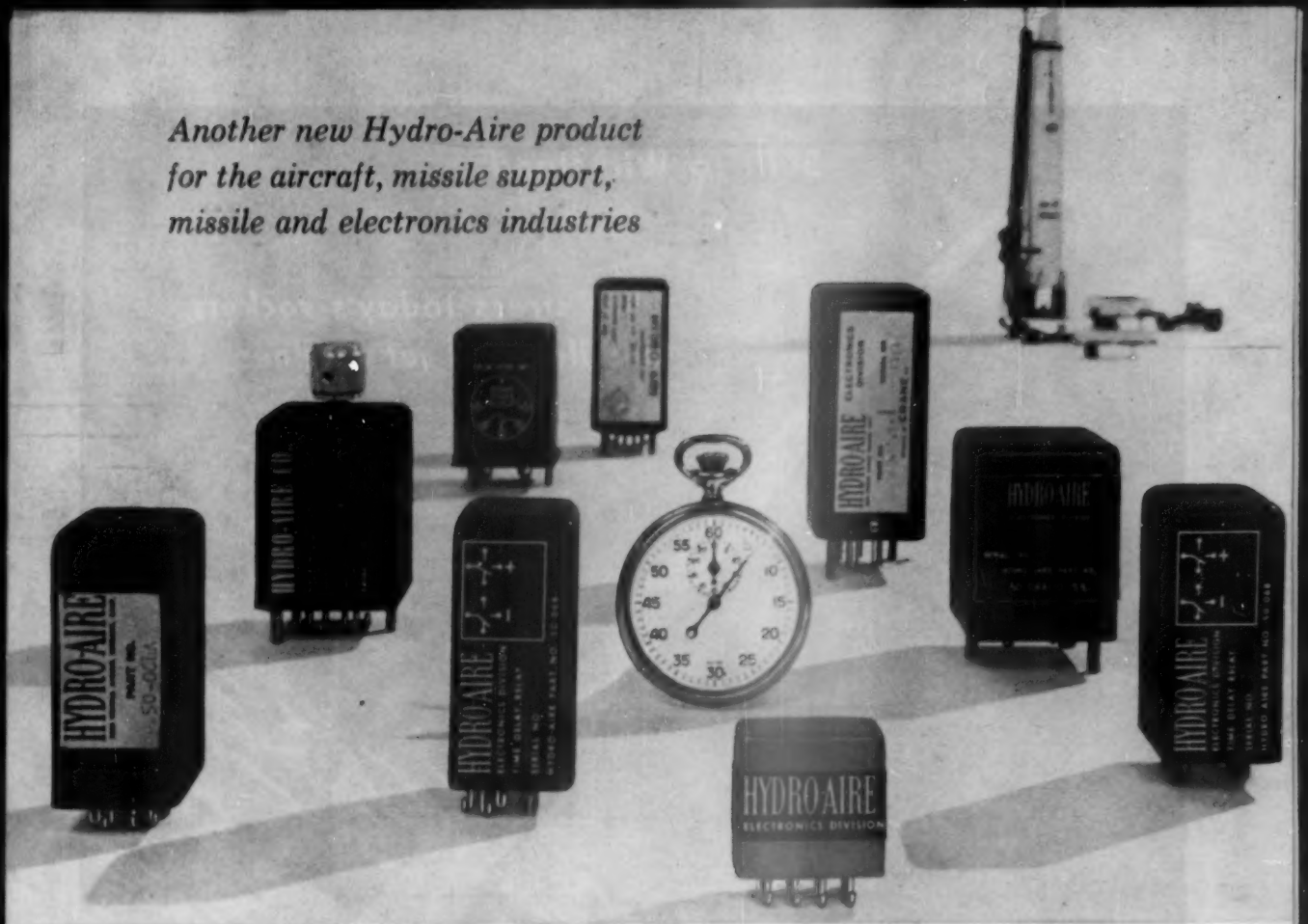

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AVIATION CALENDAR

Jan. 9-11—Seventh National Symposium on Reliability and Quality Control, Bellevue-Stratford Hotel, Philadelphia, Pa.

Jan. 9-13—International Congress and Exposition, Society of Automotive Engineers, Cobo Hall, Detroit, Mich.

Jan. 15-18—13th Annual Convention, Helicopter Assn. of America, Cherry Hill Inn, Haddonfield, N. J.

Jan. 16-18—Seventh Annual National Meeting, American Astronautical Society, Dallas, Tex.

Jan. 17-19—Winter Instrument-Automation Conference & Exhibit, Instrument Society of America, Jefferson Hotel and Kiel Auditorium, St. Louis, Mo.

Jan. 23-25—29th Annual Meeting, Institute of the Aeronautical Sciences, Hotel Astor, New York, N. Y. Honors Night Dinner, Jan. 24.

Feb. 1-3—Second Winter Military Electronics Convention, Institute of Radio Engineers, Biltmore Hotel, Los Angeles.

Feb. 1-3—Solid Propellants Conference, American Rocket Society, Salt Lake City.

Feb. 14-16—Second Annual Symposium on Non-destructive Testing of Aircraft and Missile Components (unclassified), Society for Non-destructive Testing and Southwest Research Institute, Gunter Hotel, San Antonio, Tex.

Feb. 15-17—International Solid-State Circuits Conference, Institute of Radio Engineers, Sheraton Hotel, Philadelphia.

Mar. 5-9—Sixth Annual Gas Turbine Conference and Exhibit, American Society of Mechanical Engineers, Shoreham Hotel, Washington, D. C.

Mar. 9-10—Second Symposium on Engineer-

(Continued on page 6)

AVIATION WEEK and Space Technology

December 26, 1960

Vol. 73, No. 26

Published weekly with an additional issue in December by McGraw-Hill Publishing Company, James H. McGraw (1860-1948), Founder. See panel below for directions regarding subscription or change of address. Executive, Editorial, Circulation and Advertising Offices: McGraw-Hill Building, 330 West 42nd Street, New York 36, N. Y. Printed at Albany, N. Y. OFFICERS OF THE PUBLICATIONS DIVISION: Nelson L. Bond, President; Shelton Fisher, Wallace F. Traendly, Senior Vice Presidents; John R. Callaham, Vice President and Editorial Director; Joseph H. Allen, Vice President and Director of Advertising Sales; A. R. Venezian, Vice President and Circulation Coordinator. OFFICERS OF THE CORPORATION: Donald C. McGraw, President; Joseph A. Gerardi, Hugh J. Kelly, Harry L. Waddell, Executive Vice Presidents; L. Keith Goodrich, Vice President and Treasurer; John J. Cooke, Secretary.

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Single copies 75¢. Subscription rates—United States and possessions, $7 one year. Canada $8 one year. All other countries, $20 one year.

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Second class postage paid at Albany 1, N. Y. Printed in U. S. A. Title registered in U. S. Patent Office.
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BY STANLEY M. INGERSOLL, *Capabilities Engineer*

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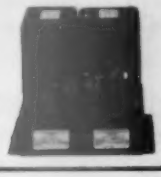
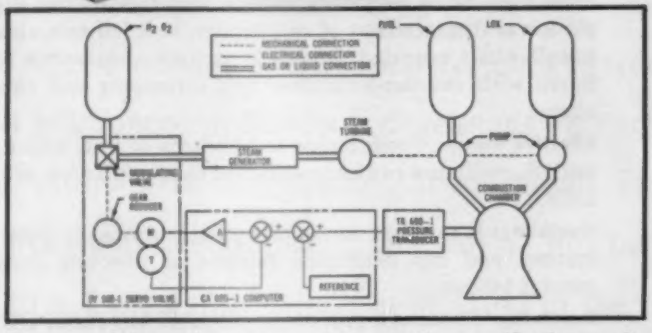
Shock	50 g's
Altitude	Sea Level to 200,000 ft.
Weight	10 pounds
Input Voltage	115 volts 400 cycles
Accuracy	better than 1% of the pressure
Valve Flow Rate	30 lb/min H_2O_2
Magnitude of Set Pressure	300-1000 psi
Slewing Speed of Valve	2-3 seconds





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AVIATION CALENDAR

(*Continued from page 5*)

Mar. 5-9—Sixth Annual Gas Turbine Conference and Exhibit, American Society of Mechanical Engineers, Shoreham Hotel, Washington, D. C.

Mar. 9-10—Second Symposium on Engineering Aspects of Magnetohydrodynamics, University of Pennsylvania, Philadelphia.

Mar. 9-10—Flight Propulsion Meeting, Institute of the Aeronautical Sciences, Cleveland, Ohio (classified).

Mar. 12-16—Aviation Conference, American Society of Mechanical Engineers, Statler-Hilton, Los Angeles, Calif.

Mar. 13-16—Test, Operations and Support Conference, American Rocket Society, Biltmore Hotel, Los Angeles, Calif.

Mar. 16-18—Fifth National Conference on Aviation Education, Mayflower Hotel, Washington, D. C.

Mar. 20-23—International Convention, Institute of Radio Engineers, Coliseum and Waldorf Astoria Hotel, New York, N. Y.

Mar. 20-24—1961 Western Metal Exposition, American Society for Metals, Pan-Pacific Auditorium, Los Angeles, Calif.

Mar. 27-31—1961 Symposium on Temperature, Its Measurement and Control in Science and Industry, Columbus, Ohio. For information: V. W. Sikora, Instrument Society of America, 313 Sixth Ave., Pittsburgh 22, Pa.

Mar. 28-29—Nucleonics in Flight Symposium, American Nuclear Society, Statler-Hilton Hotel, Dallas, Tex.

Apr. 4-5—Aviation Technician School Administrators Conference, Purdue University, Lafayette, Ind.

Apr. 4-6—International Symposium on Electromagnetics and Fluid Dynamics of Gaseous Plasma, Polytechnic Institute of Brooklyn, Brooklyn, N. Y.

Apr. 5-7—Lifting Re-entry Vehicles: Structures, Materials & Design, American Rocket Society, Palm Springs, Calif.

Apr. 10-11—Spring Meeting, Western States Section/The Combustion Institute, Aeronutronics Division of Ford Motor Co., Newport Beach, Calif.

Apr. 17-28—14th Technical Conference, International Air Transport Assn., Queen Elizabeth Hotel, Montreal, Canada.

Apr. 18-20—Symposium on Chemical Reactions in the Lower and Upper Atmosphere, Stanford Research Institute, Mark Hopkins Hotel, San Francisco, Calif.

Apr. 20-22—General Meeting, American Meteorological Society with the American Geophysical Union, Washington, D. C.

Apr. 26-28—Liquid Rockets, Propellants and Combustion Conference, American Rocket Society, Palm Beach Biltmore, Palm Beach, Fla.

Apr. 30-May 4—Seventh National Aero-Space Instrumentation Symposium, Instrument Society of America, Adolphus Hotel, Houston, Tex.

May 8-10—National Aeronautical Electronics Conference, IRE, Miami and Biltmore Hotels, Dayton, Ohio.

May 9-11—Western Joint Computer Conference and Exhibit, Ambassador Hotel, Los Angeles, Calif.

May 22-24—National Telemetering Conference, Sheraton-Towers Hotel, Chicago, Ill.

May 26-June 4—24th French International Air Show, Le Bourget, Paris, France.

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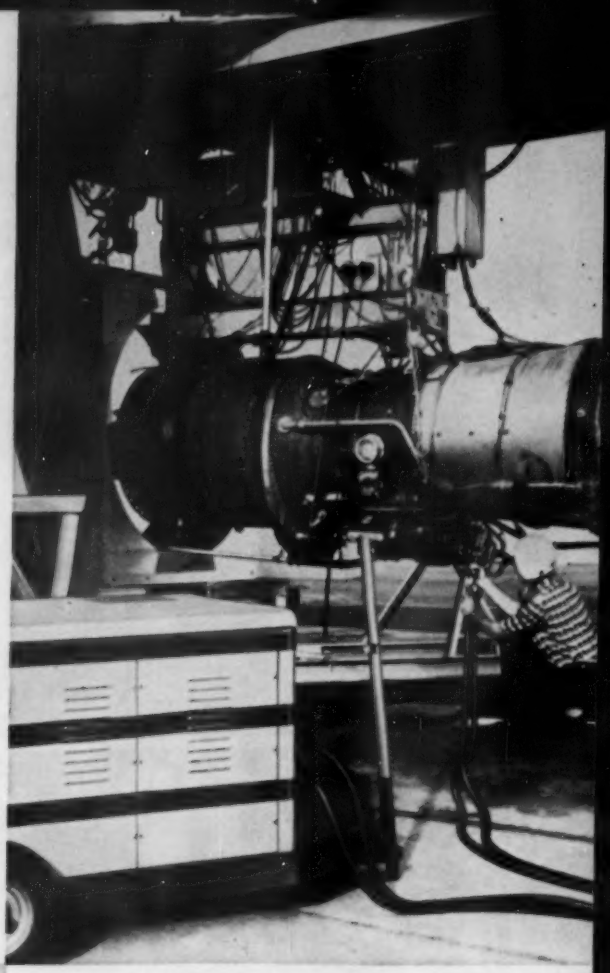

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Aviation Week and Space Technology

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COVER: New Beech Barons, designed to fill a gap between the company's Travel Air and Twin Bonanza, are in formation over Wichita, Kan. Plane is powered by Continental IO-470-L fuel injection engines; 30 Barons have rolled out so far. For other pictures and flight report, see p. 84.

PICTURE CREDITS

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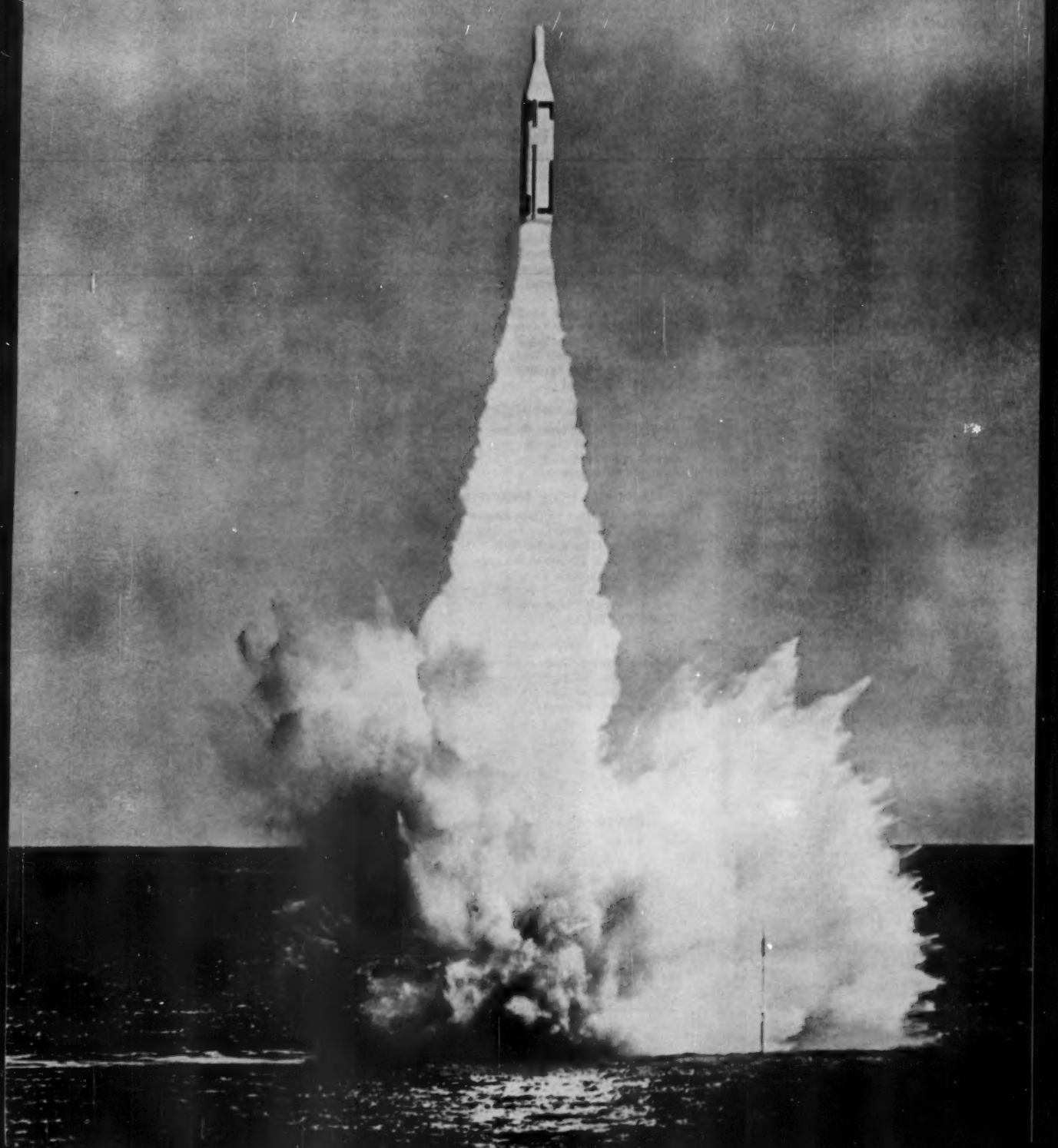
Now the Polaris is on patrol. The USS George Washington put to sea in November with an operational Polaris in each of its sixteen launching tubes. It will roam the deep for weeks on end—a missile base safe from surprise attack that will take the Polaris within range of any strategic target on earth. This mating of ballistic missile and nuclear-powered sub by the U.S. Navy marks the start of a new era of naval strategy. It brings real hope for enduring peace because it makes the penalty for aggression so certain and so harsh. Prime contractor and system manager for the Polaris missile: The Missiles & Space Division of **LOCKHEED.**



EDITORIAL

Laurels for 1960

The year now closing has brought basic changes in public attitudes toward aerospace problems and the first indications of a quickening pace for the years ahead. It was a year in which outstanding U.S. achievements in aerospace balanced more closely the frustrations and failures of prior years as many aspects of the new technologies emerged from development cocoons into initial operational forms. As the year ends, there are signs that a more vigorous and technically sound national direction may be emerging that will permit the scientific, engineering and industrial resources of this country to forge ahead, if not at the full-throttle pace of an emergency, at least at maximum cruise speed compatible with maintaining superiority for the long hard pull that faces this nation.

Here are the people, organizations and projects that we think merit permanent listing in the logbook of aerospace achievements during 1960:

• **Gen. Thomas S. Power,** chief of Strategic Air Command, for his work in bringing this key element of U.S. military strength into an effective transition to the mixed force concept, adding the ICBM and laying the foundations for the effective military operational use of outer space.

• **Elwood R. "Pete" Quesada,** Federal Aviation Agency chief, for his courage in handling the Electra safety problems on technical grounds in the face of intense political and emotional pressure and for his general forward-driving course toward better air safety.

• **Terry Drinkwater,** president of Western Airlines, for an outstanding job of airline management using relatively limited resources to produce outstanding financial and operational results.

• **Hilliard Paige,** boss of General Electric's Missile and Space Vehicle Department and his technical staff for their outstanding achievements in re-entry vehicles and data capsules and for spearheading a broad advance across the whole spectrum of space technology.

• **Scott Crossfield,** North American Aviation test pilot, not only for his initial proving flights in the X-15 but also for producing an honest, technically accurate, sound addition to the aerospace bookshelf with his autobiography "Always Another Dawn."

• **C. L. "Kelly" Johnson,** Lockheed vice president for advanced developments, belated recognition for his superb job in designing the special purpose, high altitude U-2 reconnaissance plane that was able to photograph the Soviet Union for four years without interference.

• **John Stack** of the National Aeronautics and Space Administration and his Langley Research Center associates for their successful fight to keep aeronautical research alive, particularly on the supersonic transport and NATO projects.

• **Thomas Gates,** secretary of defense, for his fine job of making the Defense Department machinery work faster and more efficiently in the relatively short period available to him to rectify the errors and indifference of his two predecessors in the Pentagon.

• **Brig. Gen. Don Flickinger,** assistant for bio-astronautics to the Air Research and Development commander, for his original efforts to organize the foundations for a bio-astronautics program in this country and his dogged persistence in pushing his program despite a wide variety of official roadblocks.

• **Boeing Airplane Co.,** for its drive to dominance in the jet transport field with its 707, 720 and 727 series.

• **Jim Austin,** president of Northeast Airlines, for his airline's drive to gather a significant share of the toughest competitive airline market in the country—the Boston-N.Y.-Washington commuter pattern.

• **National Aeronautics and Space Administration,** Air Force, Army, Navy and their industry contractors for providing the first steps demonstrating the practical operational uses of space technology with Tiros I and II weather satellites, Courier active communications repeater, Echo passive communications satellite, Transit navigation satellites and the Discoverer series.

• **Walter T. Bonney,** NASA director of information, for doing the best job of any government information officer at keeping the press and public adequately informed on the progress of space technology in the face of extremely difficult official problems.

• **Vice Adm. William F. "Red" Raborn** for his ramrodding of the Navy's Polaris solid-fuel missile into initial operational duty in a submarine at sea less than five years after the program was organized.

• **Dr. Stark Draper** and his Massachusetts Institute of Technology group for their pioneering work on development of inertial guidance systems that came to fruition in operational use with Polaris and Titan.

• **Navy Cmdr. John N. Davis** for his two closed-course world speed records set with the McDonnell F4H fighter: 1,390 mph. for 100 km. and 1,216 mph. for 500 km.

• **Sen. A. S. Mike Monroney** and **Rep. Mendel Rivers** for their leadership of a successful congressional campaign to begin the modernization of the Military Air Transport Service cargo transport fleet with jet equipment.

• **Vice President-elect Lyndon B. Johnson** for his skillful and effective operations as Senate majority leader, which resulted in a modernized and increased defense budget for Fiscal 1961.

• **Brig. Gen. Irving Branch** for his efforts to revitalize the Aircraft Nuclear Propulsion program, combining more effective management and more advanced technology.

• **Navy, Lockheed** and **Booz Allen & Hamilton** for having developed the effective PERT management technique for complex weapon system development programs, and to the Air Force for its willingness to acquire a good idea from a sister service and further develop it for its own needs.

—**Robert Hotz**

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WHO'S WHERE

In the Front Office

M. L. Lindahl and **D. C. Webster**, directors of General Precision, Inc. Messrs. Lindahl and Webster continue as vice presidents of the company's Librascope Division, Glendale, Calif.

Willis M. Hawkins, a vice president, Lockheed Aircraft Corp., Burbank, Calif. Mr. Hawkins continues as assistant general manager of Lockheed's Missile and Space Division.

Dr. Nisson A. Finkelstein, vice president-research, Stromberg-Carlson Division of General Dynamics Corp., Rochester, N. Y.

Henry M. DeRosa, vice president-marketing, Vector Manufacturing Co., Inc., Southampton, Pa.

Donald A. Gehlke, vice president-corporate director of advanced development, Babcock Electronics Corp., Costa Mesa, Calif.

Martin R. Richmond, corporate vice president of Sanders Associates, Inc., has been named head of the company's new Advanced Systems Laboratories, Burlington, Mass.

Denison Neale, vice president-marketing, Denison Engineering Division, American Brake Shoe Co., Columbus, Ohio, and **Leroy E. Bonnette**, director of engineering.

Electronic Assistance Corp., Red Bank, N. J., has announced formation of a Systems Engineering Division and establishment of a center for long-range research at Ann Arbor, Mich., and **William A. Wheatley** has been appointed vice president in charge of the division and center.

Dr. Thomas C. Hall, vice president-research and development, MicroSemiconductor Corp., Los Angeles, Calif., and **Steve Manning**, vice president-marketing.

A. S. Blodget, Jr., regional (midwestern) vice president, Air Reduction Sales Co., with offices in Chicago, Ill.

Col. Robert W. Van Wert, director of field service operations, Army Rocket and Guided Missile Agency, Redstone Arsenal, Ala.

Honors and Elections

Harold D. Hoekstra, Projects Control Officer, Engineering and Manufacturing Division, Federal Aviation Agency, Bureau of Flight Standards, has been named a Fellow of the Royal Aeronautical Society of Great Britain.

William P. Lear, Sr., board chairman of Lear, Inc., has been awarded Sweden's outstanding aviation award, the Enoch Thulin Medal, for his "pioneering work in aviation. . . ."

Dr. Samuel Herrick, principal astrodynamicist at Aeronutronic Division of Ford Motor Co., has been elected a director of the American Rocket Society.

Robert Nelsen of General Electric Co.'s Large Jet Engine Department has been elected chairman, Service Publications Committee, Aerospace Industries Assn., Washington, D. C., succeeding **H. A. Wadsworth** of the Convair Division of General Dynamics Corp. Also: **R. H. Lambka** of the Bendix Corp., vice chairman, succeeding **G. W. Jaimet** of the Allison Division of General Motors Corp.

INDUSTRY OBSERVER

► New technique which may enable an anti-ICBM defense radar to distinguish between warheads and decoys and between single and multiple targets has been developed by General Atronics Corp. under Rome Air Development Center sponsorship. This technique, not yet proven in an operating radar, uses special modulation and multiple intermediate frequency amplifiers in the radar receiver to extract increased information directly from radar echos, including direct measurement of target velocity, acceleration and spin. The technique also has application to sonar.

► **Federal Aviation Agency has taken over direction and systems management of the joint FAA-Air Force-Weather Bureau automatic weather observation-forecasting system (433-L) development program from Air Force and United Aircraft Corp. Program will now have more modest objectives and funding will be cut a third. United Aircraft still will have a major role but relinquishes systems management responsibility.**

► Proposals for an Air Force earth satellite weapon system are due in March. Two categories involved are a strategic low altitude orbital bomber (SR-79821) for deployment up to 20,000 naut. mi., under Ballistic Missile Division cognizance, and a strategic high altitude orbital bomber to operate above 20,000 naut. mi., under Wright Air Development Division.

► **Feasibility of an all-plastic airframe for the Piper PA-29 Papoose is under study at Piper's Vero Beach development center. Papoose is a low-wing, two-place, tricycle gear lightplane being designed to sell for less than $5,000 (AW Nov. 10, p. 37). It will have a sliding bubble canopy and single swept tail. Piper also is developing a higher-powered model of the Pawnee argricultural aircraft, using a 250 hp. Lycoming engine derated to 235 hp.**

► Air Force will instrument one of three Titan training facility silos at Vandenberg AFB for remaining objectives in the operational suitability test facility program. Titan explosion damaged the OSTF silos too extensively for repair to be practical.

► **Navy will evaluate the Kaman HU2K as an anti-submarine warfare aircraft. The helicopter's ASW equipment will be a Raytheon AQS-12 dipping sonar system weighing 300 lb. and using a 300-ft. cable, considerably longer than cables on currently operational sonar systems.**

► Nike Zeus test vehicles will be fired at inert Atlas warheads capable of deploying decoys in later phases of the test program at Kwajalein Island. Initial phase is scheduled to begin next summer with Zeus shots against Atlas-D ICBM warheads without decoy capability. Atlases will be fired from Vandenberg AFB.

► **Navy has narrowed the group of contenders for its new Typhon surface-to-air missile system to about a half dozen companies. The group includes McDonnell Aircraft Corp. and Raytheon.**

► Dual-function Sundstrand Aviation electric starter-drives will be used on the Boeing 727's Pratt & Whitney JT8D engines to eliminate the need for compressed air starter units now used with jet transports. Using a constant speed drive, the Sundstrand unit will use external power to operate as a starter, then become a 400 cps. a.c. generator after the engine is started.

► **Proposals for a study contract to survey Pacific Missile Range requirements for a medical-technology facility are due Jan. 3 at the Navy Procurement Office in Los Angeles. Companies invited to submit proposals for fixed price contracts include Avco Research, Douglas, Autonetics, Hadden Byrne & Co., Medtronic, Stanford Research Institute and Minneapolis-Honeywell.**

► Japanese National Self Defense Agency Ground Staff is expected to begin operations research on a high speed reconnaissance aircraft in the next fiscal year. Ground Staff originally wanted to build an aircraft like the Grumman Mohawk turboprop but Japanese manufacturers reported that it would be impossible to build such an advanced type on the budget proposed.

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NOTE TO MISSILE PROJECT MANAGERS:
If you are not familiar with the latest developments in the use of Exploding Bridgewire techniques as a replacement for squibs, detonators, and other ordnance functions, write for Technical Bulletin 33.

LIBRASCOPE DIVISION • GENERAL PRECISION, INC.

Washington Roundup

Livelier Space Council

An extremely active National Aeronautics and Space Council can be expected now that President-elect John F. Kennedy has named Vice President-elect Lyndon Johnson as its chairman. Kennedy left unanswered what part he will play personally. The Space Act states that the President "shall preside over meetings," but this and a number of other things may be changed.

President Eisenhower never appointed a civilian staff. Johnson is expected to do this, probably picking Kenneth E. BeLieu or Max Lehrer as executive secretary at $20,000 a year. BeLieu has been staff director and Lehrer assistant staff director of the Senate Committee on Aeronautical and Space Sciences. Both are close to Johnson and have been prime movers in the Senate committee's work. Lehrer also is considered a strong possibility for the comptroller's job in the Defense Department.

Advice to the President on scientific matters will be handled quite differently in the new Administration if Dr. Jerome B. Wiesner of Massachusetts Institute of Technology succeeds Dr. George B. Kistiakowsky as the chief White House science aide.

Wiesner, who was Kistiakowsky's personal choice as a successor, feels the current Scientific Advisory Committee has directed Defense Department scientific matters to a far greater degree than should be necessary, chiefly because too many people in technical jobs at the Pentagon weren't sufficiently able in technical matters.

Wiesner headed the technical staff of the Gaither Committee and has offered advice on defense matters to the Kennedy group since before the national political conventions.

NASA Supplemental

Congress will be asked for a special supplemental appropriation of about $50 million by National Aeronautics and Space Administration. The money would pay for NASA's active communications satellite program, the Rover nuclear rocket program, the Centuar liquid hydrogen upper stage rocket and the Scout solid rocket. Major portion of the funds are for the communications satellite work.

Industry is pushing USAF Maj. Gen. Joseph "Smoky" Caldara for FAA administrator because of his background in aviation safety. Najeeb E. Halaby, secretary-treasurer of Aerospace Corp. and a board member of the Flight Safety Foundation, also is a strong candidate. He is a former Navy pilot and associate of Laurence Rockefeller, was a deputy assistant secretary of defense, and helped write the Curtis report on aviation facilities. Kennedy's personal choice at the moment appears to be Clarence D. Martin, southern California businessman. Martin also is being considered for secretary of the Navy (see p. 21). Eastern Air Lines Capt. Jimmie H. Singleton also is seeking the job.

Dave Black, assistant attorney general of Washington state is a likely appointee to the Civil Aeronautics Board, while Alan Boyd, now a member, is being pushed by Kennedy's close friend, Sen. George Smathers (D.-Fla.) for the chairmanship.

Trevor Gardner, trustee of Aerospace Corp. (see p. 21) and former USAF assistant secretary for research and development who resigned in protest over Eisenhower defense policies, is a strong contender for the job as Kennedy's arms control director, either in the White House or at State Department's disarmament unit.

ANP Milestone

Aircraft nuclear propulsion program passed a major technical milestone in mid-December with the first successful nuclear start of General Electric's HTRE-3 engine. Earlier tests required starting and running on conventional fuel until the reactor reached proper operating conditions.

Meanwhile, the program faces the worst budgetary hurdle in the past 10 years. The Budget Bureau still refuses to release Air Force's Fiscal 1961 funds for engine machinery development. Counterpart Atomic Energy Commission funds for reactor development have been released. The money is split about 50-50 between the two agencies, totaling $150 million in the Fiscal 1961 budget.

A major overrun on its first big development program has hit the Federal Aviation Agency's Bureau of Research and Development hard. The program is General Precision's automatic data processing system.

To prevent future overruns, the bureau has tightened procurement policies drastically, using fixed-price contracts wherever possible, introducing maximum ceilings on cost-plus-fixed-fee contracts, and inserting penalty clauses for late delivery in a few contracts. It also is using increased profit incentives where the contractor is able to shave costs.

The usual passion for abbreviation in weapon system names has led one company to call its study on an Air Force strategic low orbit bomber (see p. 13) by a distinctive acronym—SLOB.

—Washington Staff

Space Technology

Mercury Flight Test Tempo Quickening

Atlas, Little Joe, MR-2 will follow MR-1 success; Redstone-boosted manned mission may fly in March.

By Edward H. Kolcum

Washington—Tempo of the Project Mercury flight test program will increase following the successful ballistic flight last week of a production-line capsule in a mission designed to qualify the manned satellite structure and some of its components in the space environment.

Redstone-boosted (MR-1) capsule flight was made Dec. 19, and will be followed quickly by these three development launches:

- **Mercury-Atlas 1 (MA-1),** in a repeat of a test of capsule performance in a high-angle re-entry which failed in July (AW Aug. 8, p. 26).
- **Little Joe,** repeating qualification test of the capsule in a maximum pressure abort which failed last month (AW Nov. 14, p. 34).
- **Mercury-Redstone 2 (MR-2),** which may carry a chimpanzee on a ballistic flight. Launch could be made in mid-January and if successful, would set the stage for MR-3, a manned ballistic flight, possibly by March.

McDonnell Aircraft Corp. has delivered eight capsules in an order which will total 24. Four capsules have been flown, and four are ready for early test launches. Present plan is to use each capsule only once.

Precise profile flown by MR-1 is a milestone in the Mercury development program because it was the first completely successful rocket-boosted mission with a production capsule payload in three attempts (AW Dec. 5, p. 30). Atlas and Little Joe profiles will be flown again.

Redstone malfunction Nov. 21 was fixed with some relatively minor changes, and the same capsule was used for the MR-1 experiment.

Fast Recovery

Adding to the optimism of the Dec. 19 test was quick recovery of the capsule, even though high winds carried it 15 mi. beyond the expected impact point to a 235-mi. range. Marine HUS helicopter picked the capsule up 31 min. after launch and 15 min. after it landed.

The one-ton capsule was deposited on the deck of the aircraft carrier USS Valley Forge 17 min. after it was recovered.

Project engineers are now making a detailed analysis of the structure and components and plan to test to destruction some of the structural elements, such as exterior shingles, in order to determine the effects of space flight on tensile strength. The capsule appeared to be in excellent condition when it was returned to Hangar S at the Atlantic Missile Range, with the only visible damage being a broken pane of glass in one porthole. Broken pane is the outermost of three panes, and breakage did not affect watertight integrity or internal capsule pressure.

When the capsule was opened after its flight, all batteries were live, all cockpit illumination lights were on, the system sequence indicators showed a normal flight had taken place, the ventilation fan was working, and the recovery light was flashing.

Actual flight differed from the programed profile only in impact range, attributed to winds of nearly 100 mph. at altitude. The 16-min. mission began with a 140 sec. boost phase during which gravity forces built up to 6g and velocity to 4,200 mph. At Redstone burnout, the escape tower was jettisoned and three posigrade rockets under the heat shield were ignited to ensure separation. Automatic stabilization and control system hydrogen peroxide jets then damped out capsule oscillations and, five seconds after separation, turned it 180 deg. so the heat shield was forward.

The vehicle coasted to 135-mi. altitude, and near apogee, reaction control jets lifted the capsule face 35 deg. above horizontal in order to orient it for retrorocket ignition. Retrorockets were fired, and the rocket package beneath the heat shield was jettisoned. The stabilization and control system oriented the capsule in a shield-down attitude, and it fell free to 21,000 ft., when the drogue parachute deployed. Re-entry forces of 10g were recorded.

At 10,000 ft., the antenna housing was jettisoned and the 63-ft. ringsail main parachute deployed. Redstone heat shield was beryllium, but an ablating shield will be used on MA capsules.

National Aeronautics and Space Administration's Space Task Group is experimenting in Redstone flights to determine the optimum altitude at which to deploy the drogue chute and to determine whether oscillations will cause premature deployment at high altitude.

Among manned satellite components tested in the flight were separation rockets and retrorockets, a modified instrument panel (AW Dec. 19, p. 27), recovery aids and performance sensors.

Communications System

The communications system included two four-channel telemetry transmitters which provided continuous data on vehicle attitude and environment. Heating, pressure, noise and vibration were measured by 90 sensors in the capsule.

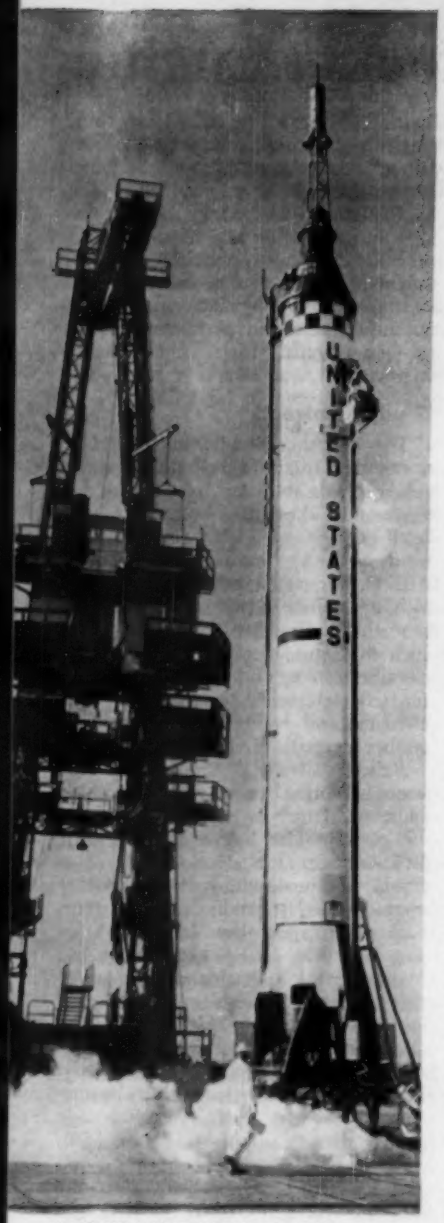
Booster used in the MR program incorporates a number of significant alterations in the standard tactical Redstone. Among the modifications made by NASA's Marshall Space Flight Center are:

- **Container section,** elongated by adding 6 ft. to the tank and 6 ft. to the booster to increase fuel capacity for 20 sec. more burning time. Vehicle is 83 ft. long compared with the 69 ft. Redstone. Takeoff weight is 66,000 lb., 5,000 lb. more than Redstone.
- **Engine,** modification of the advanced A7 Redstone, fueled by alcohol and liquid oxygen instead of Hydyne and Lox for more reliable fueling operations. Liftoff thrust levels—78,000 lb.—are identical.
- **Abort system,** developed specifically for the MR program. System was carried open loop on MR-1 flight so its operation could be assessed for later missions. Sensors monitor pitch, yaw and roll in attitude and angular velocity, voltage loss, connector separation, and combustion chamber pressure.
- **Control system,** using minimum drift LEV-3 autopilot connected to carbon vanes in the propulsion exhaust and jet vanes.
- **Instrument compartment** and adapter section were designed to house sensors

High Minuteman Bids

Los Angeles—Lowest bid received by Army Corps of Engineers for the construction of Minuteman launch and control facilities at Malmstrom AFB, Mont., was more than 50% over the government estimate of $50,816,500.

After discussions with USAF, the Corps of Engineers may ignore the first round and advertise for new bids. Four teams of construction contractors bid in the first round, and the highest bid was $98,500,000. The low bid of $78,907,000 was made by the team of Pomeroy, Hawaiian Dredging and Construction, Bates & Rogers, and J. Rich Steers construction companies.



REDSTONE-BOOSTED Project Mercury capsule is ready for launch on its first successful suborbital flight. Capsule went to 135-mi. altitude and 2,5-mi. range.

in a pressurized compartment and provide a stable means of joining booster and payload.

Booster performance during the flight was recorded on the basis of measurements by 50 sensors.

NASA Space Task Group had determined prior to the MR-1 mission that helicopters would be the primary means of capsule pickup, limited only by a maximum flight over water of 75 mi. Recovery force in the high-probability landing area for the MR-1 mission consisted of six destroyer-type ships and an amphibious dry dock.

National Security Council Changes Urged in Jackson Group's Report

Washington—Senate National Policy Machinery Subcommittee criticized the highly institutionalized and "ritualistic" nature of the National Security Council and urged that it be reorganized into a small group to advise the President effectively on top—and only top—national security issues in a report issued last week.

The group, headed by Sen. Henry Jackson (D.-Wash.), pictures NSC as a "policy paper production" system aiming at "agreement" rather than the best solution, and as ineffective in translating its decisions into positive action.

The council now holds regular weekly meetings with as many as 30 to 40 officials attending. The subcommittee commented that "the sheer number of participants . . . limits the depth and dilutes the quality of the discussion." The statutory NSC members are the President, Vice President, the Secretaries of State and Defense, and the Director of Civil Defense Mobilization. The statutory advisers are the Director of the Central Intelligence Agency and the Chairman of the Joint Chiefs of Staff.

Planning Board

NSC is overshadowed in importance, if not prestige, the subcommittee said, by its Planning Board, "the heart" of the policy paper production system. This substructure is composed of interagency representatives at the assistant secretary level and is responsible for the final content and language of the reports considered by the Council. "The Planning Board, by its very nature, is not a creative instrument for developing and bringing forward imaginative and sharply defined choices, particularly in uncharted areas of policy. Inter-agency committees of this kind have a built-in drive toward lowest common denominator solutions. They can comment, review, and adjust. But they are not good instruments of innovation."

Noting that the main source of "imaginative proposals" is the individual, the subcommittee suggested that in the interest of "an agreed solution," the Planning Board tends to "blur the edges and destroy the coherence of these proposals."

Another substructure, the Operations Coordinating Board, which has the task of follow-through on council decisions, the subcommittee noted, is also an inter-agency group and "lacks command authority. It can advise, but not direct, the operating agencies." OCB, composed of representatives at the under secretary level, "has little impact on the real coordination of policy execution. Yet, at the same time, the existence of this elaborate machinery creates a false sense of security by inviting the conclusion that the problem of teamwork in the execution of policy is well in hand."

Commenting that NSC policy papers are "mere statement of aspirations" unless they result in action, the subcommittee added:

"They are policy only if they cause the government to adopt one course of conduct and to reject another, with one group of advocates 'winning' and the other 'losing.' It appears that many of the papers now emerging from the Council do not meet the test of policy in this sense."

Recommendations by the Jackson subcommittee were:

- **Council should meet** when the President wishes advice on some matter. Regular meetings tend to generate business not demanding presidential attention simply because of the necessity of having "something" to discuss.
- **Objective of Council discussions** should be to present sharply divergent views of advocates. The goal is not to spare the President the necessity of choice, but to make his choice more meaningful, the subcommittee said.
- **Council meetings should** be kept small, and top officials, not aides, should present what "they themselves" think—not some "agreed to" position.
- **Planning Board function** should be to criticize and comment on policy initiatives developed by the departments and not the securing of departmental "concurrences." Outside committees of distinguished citizens occasionally could be "highly useful in introducing fresh perspectives on critical problems."
- **"The case for abolishing** the OCB is strong." Responsibility for implementation of a policy cutting across department lines could be assigned an "action officer."
- **A member of the Council** of Economic Advisers might replace the director of Office of Civil Defense Mobilization as statutory member of NSC. The OCDM director was designated to bring "domestic perspective" to the council, but, the subcommittee pointed out, OCDM focuses on mobilization problems of wartime emergencies.
- **NSC should participate** at the target-setting stage of the annual budget preparation to assure that its views are reflected.

USAF May Order Fluorine Rocket Engine

By Michael Yaffee

Air Force, seeking more payload for its satellites, is expected to award Bell Aerosystems a contract shortly for work on a fluorine rocket engine in the 15,000-lb.-thrust class.

The engine could evolve into a powerplant for a new high-energy upper stage that would be used on an Atlas in place of the Centaur. A fluorine-powered vehicle with approximately the same exterior dimensions as the Centaur stage could carry almost 50% more payload.

Air Force Ballistic Missile Division is known to be interested in the development of a more powerful second stage for the Atlas booster and is doing a significant amount of planning along this line. Because of past and current controversies, however, BMD will not issue any bid requests or even discuss a definite program for any high-energy upper stage until it develops a definite mission requirement for such a vehicle.

BMD may propose the vehicle for several Air Force systems and missions. Some observers feel sure that at least the initial payloads for any new Air Force high-energy upper stage that is developed will be satellites. One likely candidate is the passive communications satellite that may result from the Air Force's Project Csar (AW Dec. 19, p. 71).

Centaur Envelope

At present BMD is interested in a vehicle that would fit roughly the Centaur stage envelope. It is faster and less expensive, one Air Force officer points out, to change the second stage rather than to alter the big first-stage booster.

Both Bell and BMD say they now have enough fluorine rocket experience to build a fluorine engine and have it ready for its preliminary flight rating test within 24 months.

In addition to developing a definite mission requirement, BMD finds it must overcome the prejudices associated with the use of fluorine. Prime current bogy, says one BMD officer, is the fear of launch disasters in the event of an abort or propellant spillage.

Ballistic Missile Division is quick to point out that even if a definite requirement develops for a new high-energy upper stage, there is no guarantee that it would use fluorine or fluorine-based oxidizers or that, if it did, Bell would win the contract. At this time, one officer declares, there is no significant connection between the pending contract to Bell for work on a fluorine rocket engine and the BMD's anticipated requirement for a new high-energy upper stage vehicle.

Nevertheless, it is generally felt that the engine contract, which is now at ARDC headquarters for approval, will make Bell a prime contender for the Air Force's high-energy upper stage program if it materializes. For one thing, it is known that Bell has already prepared a proposal for a high-energy upper stage based on a fluorine rocket engine. For another, the several new and highly promising high-energy propellant systems now under study (AW Dec. 5, p. 38) fall far behind fluorine in their state of development.

There seems to be little question that the Air Force wants and needs higher performance in its satellite carrier vehicles. In its Discoverer program, for example, the Air Force has switched to RJ-1 fuel from RP-1 in the Atlas just for a fractional gain in specific impulse, according to one BMD engineer.

In the fluorine rocket engine field, the only real competitor Bell appears to have is Rocketdyne which developed a fluorine rocket engine system called the Nomad for the Air Force. But even here, the Bell engine currently appears to have the inside track by virtue of its turbopump feed system. The Nomad was a complete upper stage system that was designed to go on top of the Atlas. But the Air Force had no definite program or mission that required the Nomad vehicle, according to a BMD spokesman, so the funding gradually ceased, and work on the Nomad ended last May.

More important, the BMD spokesman adds, the Nomad engine used a pressurized propellant feed system which counterbalanced most of the performance gains afforded by the use of fluorine. The pressure-fed system, compared with a turbopump system, required heavier tankage and a lower combustion chamber pressure. The heavier tankage cut about 4% off the mass fraction while the lower chamber pressure dropped specific impulse approximately 10 sec. The net effect, he says, is that the Nomad didn't come out much better in performance than the conventionally-fueled Agena rocket engine.

'Study Contract'

The engine contract which ARDC is expected to award Bell shortly is referred to as a study contract by the Air Force and will probably be administered by the Air Force rocket group at Edwards AFB. At the present time, it is at ARDC "for review prior to signature." While it will be classified, it is believed that the contract will cover work on such things as injector patterns, thrust chamber cooling and design, heat transfer characteristics, combustion efficiencies, and sealing requirements in connection with the fuel.

Bell has already developed a "breadboard" fluorine rocket engine in work sponsored largely by NASA (AW Sept. 19, p. 34). The NASA contract with Bell was for the development of a liquid fluorine-liquid hydrogen rocket engine. The last firings in this program took place in October. In its work for the Air Force, Bell is expected to use hydrazine or a hydrazine-unsymmetrical dimethyl hydrazine blend as the fuel instead of hydrogen. Although the hydrogen-fluorine combination offers higher specific impulse (470 sec. vs. 429.5 sec. at 500 psia.), the hydrazine-fluorine mixture provides considerably higher density impulse (571 vs. 259).

This switch in fuels, however, has also created some problems. In the fluorine-hydrogen engine, the hydrogen was used to cool the thrust chamber and to drive the turbopumps. Now, in order to use hydrazine for these purposes, Bell engineers must redesign the cooling passage geometry and develop a hydrazine gas generator that will drive the turbine for the pumps. As a result of the fuel change, they must also redesign the injector and the pump itself as well as develop sealants and a sealing arrangement for the fuel system.

Bell engineers plan eventually to lower the operational combustion pressure in order to lighten the thrust chamber. This will mean redesign of the thrust chamber and will entail considerable experimental work in which chamber designs and pressures are varied to find the optimum combination. Bell has also been experimenting with non-

R Mixture Ratio, lb. Oxidizer/lb. Fuel		ISP Theoretical Specific Impulse		D Bulk Specific Gravity			ISP (D) Density Impulse	
	F_2	O_2	F_2	O_2	F_2	O_2	F_2	O_2
N_2H_4 ...	2.37	0.95	429.5	370.0	1.33	1.066	571	394
H_2	10.1	5.0	479.0	466.0	0.54	0.32	259	147

PERFORMANCE of Bell's fluorine rocket engine has not been disclosed. But the company recently put together the above table which compares high-energy propellant systems under what are said to be "realistic" conditions. The conditions assumed are equilibrium expansion, a combustion chamber pressure of 500 psia., a nozzle expansion ratio (exit area/throat area) of 50 and a nozzle exit pressure equivalent to a vacuum.

cryogenic, high-energy oxidizers such as chlorine trifluoride. Handling and pumping liquid fluorine, however, is no longer considered a problem by Bell.

If the pending engine contract should lead Bell to an Air Force contract for a high energy upper stage vehicle, it is believed that Bell Aerosystems would develop or be responsible for the complete system under the aegis or BMD. While this is somewhat unusual for an engine manufacturer in the liquid propellant rocket field, it is essentially the same pattern that was followed in the case of Rocketdyne's Nomad program. Moreover, Bell points out, the company has had systems responsibility before in the case of the Rascal.

Although no one is underplaying the importance of the engine contract, it is generally agreed that the big plum will be the program for the complete high-energy upper-stage system. Provided that this latter program does materialize, the best estimates of when it will materialize in terms of actual requests for proposals currently range from six months to two years.

First Soviet Tu-114 Scheduled Flights Set

Moscow—Tupolev Tu-114 turboprop airliner will begin regular nonstop passenger service from Moscow to Khabarovsk in January, according to Tass.

The four-engine transport has undergone an unusually long proving period of more than two years, although it reportedly has been used on cargo flights to the Far East during this period. It also was called into courier service from Moscow to New York during the recent Khrushchev appearance before the United Nations, and carried the Soviet premier to the U.S. for his first visit in the fall of 1959.

Last January an Aeroflot official told the Soviet press that the Tu-114 would be pressed into regular service in the second quarter of 1960, but this failed to materialize.

Tass notes that the 4,300-mi. Moscow-Khabarovsk route is one of the longest in the world.

The Tu-114, according to Tass, "takes 170 passengers and even has cabins with sleeping berths. There is a tourist version seating 220." Previous reports have said the plane can haul 12-14 tons of freight in addition to passengers.

The aircraft is expected to fly Moscow-Khabarovsk in 10-12 hr.

The Soviet journal Grazhdanskaya Aviatsiya reported last summer that airports at Moscow (Vnukovo), Khabarovsk, Sverdlovsk, Omsk, Novosibirsk and Irkutsk were preparing to service Tu-114 flights. There is no indication that service to other points is planned.

USAF Approves Anti-Icing Fuel Additive for B-52s, KC-135s

New York—After extensive tests in Boeing B-52s and KC-135s, Air Force has approved the use of a new anti-icing jet fuel additive by the Strategic Air Command.

Development of successful anti-icing additives is expected to have significantly more impact, however, on the performance of the North American B-70, Lockheed U-2, Convair B-58 and F-106 and other advanced aircraft than on the B-52 and KC-135 in which inflight ice formation has now been reduced to a minor problem.

If the U-2 that went down in Russia (AW May 16, p. 26) had had an effective anti-icing additive, unofficial Air Force opinion now is that the U-2's engine would not have flamed out, according to one Air Force engineering officer.

In the case of the B-70, North American has already carried out preliminary studies on the compatibility of the additive and the aircraft's fuel system. These and similar studies by other airframe manufacturers, says SAC, indicate that the additive will prove satisfactory in most jet aircraft fuel systems.

The anti-icing additive now approved by the Air Force is PFA 55MB, a petrochemical derivative developed by Phillips Petroleum Co. There are other additive materials still undergoing evaluation, at least two of which appear equally promising, according to the Air Force. After the current evaluation program is finished, the Air Force plans to use the data it has gathered as the basis for a definitive additive specification in order to keep the market open for any company that wants the specifications.

Additive PFA 55MB is the subject of a patent application by Phillips and the company will not disclose its composition. But AVIATION WEEK has learned that the compound is 90% methyl Cellosolve (a glycol ether manufactured by Union Carbide) and 10% glycerine. The Cellosolve is the actual anti-freezing agent. The glycerine was added later to make the material compatible with the Buna-N top coating on the B-52 and KC-135 fuel tanks.

Briefly, the additive which is dissolved in the jet fuel works by partitioning into (that is, preferentially dissolving in) the water that settles out of jet fuel as the temperature drops. The additive, much like salt added to ice, lowers the freezing point of the water almost, says Phillips, to the freezing point of the fuel itself. If ice has formed, PFA 55MB turns it to slush.

The Air Force search for an effective fuel additive to prevent in-flight ice formation began with the crash in February, 1958, of a B-52 that didn't quite reach the runway at Ellsworth AFB in South Dakota due to fuel starvation. Examination of the wreckage showed that the main filters had been clogged with ice. The Air Force then went to industry with a request for anti-icing additives. An evaluation program was set up and, to date, the Air Force working with Boeing Airplane Co., has screened more than 200 compounds submitted by several different chemical and petroleum companies.

At the same time it began the additive work, the Air Force started exploring other approaches to the B-52 icing problem. These other approaches led to the development of fuel line heaters, redesign of the fuel tank boost pumps, revision of the aircraft's drop tank transfer system and relocation of the main fuel line filter. As a result of these changes, says a SAC officer, the fuel icing problem in the B-52 and KC-135 is now more of a nuisance than a problem. However, he adds, fuel icing is still a very real problem in many other existing jet aircraft, particularly in the Lockheed T-33, and a problem that is expected to become even more critical in future high performance aircraft.

Cessna Sells T-37B Trainers to Peru

Wichita—A $3,338,864 contract from the Peruvian government for an "undisclosed number" of T-37B side-by-side twin-jet trainers has been announced by Cessna Aircraft Co., here, confirming an earlier report (AW Dec. 12, p. 37) that Peru had purchased 15 of the airplanes.

The contract, negotiated directly between Peru and Cessna, includes spares, maintenance equipment and special tools. First delivery of T-37Bs to the Peruvian air force will begin in February, 1961, and continue through December.

Technicians of Cessna and Continental Aviation & Engineering Corp., builders of the J69 turbojet engines, will assist the Peruvian air force in phasing in the new jet trainers and in establishing a maintenance organization.

The contract marks the first sale of the T-37 abroad and Cessna says that it hopes that this will generate further foreign interest. The company has built more than 500 T-37s for USAF and current contracts, including the one with Peru, extend trainer production through January, 1962.

Germany and France Plan Joint Supersonic VTOL Fighter Role

By Cecil Brownlow

Bonn—West German and French governments officially announced last week that they have agreed to "study" and jointly produce a "high-performance" VTOL fighter. Italy and Great Britain also are expected to join in the project to some degree.

No speed regimes were mentioned in the announcement, but it is known that a German combine of Messerschmitt-Heinkel and Bolkow has been working on plans for a Mach 3 VTOL as a replacement for the soon-to-be-introduced Lockheed F-104G (AW Dec. 5, p. 72). West German planners, who also want a close support fighter and transport within their VTOL family, see the need for such an aircraft within the next six to seven years.

In France, Dassault, working with limited funds, has been studying plans to convert its Mach 2 Mirage III fighter into a VTOL under the project designation of Balzac. The Germans, however, view Mach 3 as a near minimum speed for the aircraft.

It also was formally announced in Paris last week that Italy has joined the European production effort on the F-104G (AW Nov. 21, p. 26.), joining Germany, Belgium and Holland, amid indications that the over-all project may become an official program of the North Atlantic Treaty Organization, a move that could aid in cutting rising costs.

Order Boosted

In another move, Lockheed Aircraft Corp. said that West Germany has boosted its order for Lockheed-produced F-104Gs. Follow-on order for 30 boosts the number for Lockheed-produced aircraft on order by the West German air force to 99 F-104Gs plus 30 two-seat trainer versions. The orders are designed to give the Air Force an early F-104 capability and fill the gap until licensed production aircraft begin rolling off European lines in late 1961.

The German-French VTOL agreement marks the second attempt by the two nations to build a VTOL project in common. First attempt was centered on a coleopter design largely developed by Snecma, a state-owned French engine manufacturer. This project, however, has been dropped.

Leading VTOL studies now under way in the two countries both envision use of Rolls-Royce powerplants. Rolls is working with the German firm Maschinen Fabrik Augsburg-Nuremburg (MAN) on joint development of an advanced powerplant for the Mach 3 VTOL, and it is understood that Dassault is considering fitting a Rolls RB.108 engine to a Mirage III prototype for experimental tests.

Breguet also has been studying the VTOL problem in France, but at a low pitch, and the Balzac appears to be this country's leading entry. Both the Balzac and West Germany's Mach 3 VTOL are still largely paper designs, but officials of the latter project already are drafting plans that carry the aircraft through its prototype stage.

Britain and Italy, which have subsonic VTOL designs, also are expected to come into the program and, if Germany can gain support from its two other F-104 production partners, Belgium and Holland, by the expected promise of subcontracts, the project will have powerful support in its bid to capture the current NATO competition in the VTOL field.

Unless the odds appear insurmountable, however, Holland probably will enter the competition on its own with a Fokker design based on criteria supplied largely by Republic Aviation Corp., which has a major interest in the Netherlands firm.

Italy already is loosely bound to the Franco-German program by a 1957 agreement in which the three nations decided to work together on VTOL and STOL design projects. Great Britain decided last July to join these three countries on a relatively informal basis.

Italy also would be offered subcontracts in any production and, both to satisfy its own needs and gain support for its supersonic project, Germany might agree to either buy follow-ons to the Fiat G.95 subsonic design proposal based on the G.91 or Britain's Hawker P. 1127 as a close-support fighter.

NATO Opposition

There is opposition in some NATO quarters to such an aircraft, and Germany also might agree to push its merits within the councils of this organization as a common close-support vehicle.

Announcement of Italy's entry into the F-104 production family was made in a NATO statement issued in conjunction with the Paris Defense Ministers' Conference despite the fact that officially the program is still one between individual countries, rather than a common project under NATO sponsorship.

United States officials have been pumping for its adoption as a common NATO program because of its obvious advantages in ease of planning, coordination and savings in cost.

As a national program, for example, regular customs duties must be paid on components shipped from one nation to another, a sizable sum in the case of the F-104; there are few if any tax advantages. NATO programs are exempt from such taxes and customs, and the savings could help combat the creeping costs of the F-104G—from an estimated $1,175,000 per aircraft earlier this year to the present figure of over $1.5 million.

Fiat Production

No mention was made in the announcement of the number of aircraft Italy will build in the production program or the number its air force is scheduled to receive. Fiat, however, is expected to build a total of 182 airframes, 100 of them for the Italian air force, 82 for West Germany.

U.S. Mutual Aid funds are financing the equivalent of 25 of the Italian aircraft and is supporting a similar number for Belgium and Holland whose air forces also are scheduled to each receive 100 F-104s. Germany is supporting all its orders which may reach a total of 778 aircraft including those purchased directly from the U.S.

In view of the current dollar shortage and government insistence upon cutting foreign expenditures, aid to these three nations will be supplied primarily in the form of components manufactured in the U.S., rather than through straight dollar transactions.

UAC German Holdings

Geneva—United Aircraft Corp. is increasing its holding in the German firm of Weserflugzeugbau GmbH. in addition to its acquisition of 15% of the stock in the French firm of Ratier-Figeac (AW Dec. 19, p. 37).

Ratier-Figeac has been manufacturing Hamilton Standard propellers and components under license for the past six years. Organized in 1951, the firm has its headquarters in Paris and manufacturing facilities in southwestern France.

United is boosting its holdings in Weserflugzeugbau from an estimated 10% to a major minority interest. Weserflugzeugbau already is manufacturing under license two prototypes of the Sikorsky S-64 flying crane for the West German air force. Production orders are expected to follow; German-produced versions of the helicopter also may come from France and Italy as well as from the West German army and navy.

The U. S. firm already holds a substantial interest in the French engine firm Snecma and French avionics firms, Societe-Precilec and Societe-Somalec.

Kennedy Defense Approach Takes Shape

By Ford Eastman

Washington—President-elect John F. Kennedy's approach to Defense Department problems began to take shape last week when he named Roswell Gilpatric, chairman of the Aerospace Corp. board of trustees, his deputy defense secretary.

Gilpatric, a New York lawyer, has had considerable experience in the defense and foreign policy fields, while Robert S. McNamara, named Defense Secretary a week earlier, is an industrialist who moved up through the ranks of the Ford Motor Co. to become its president in 14 years, but who has had no previous government experience (AW Dec. 19, p. 28). Appointment of the two for the top posts will blend defense experience with business experience.

Both men are similar in that they are respected by leaders in their fields and have gained wide reputations as being energetic, hard-working, hard-driving, certain of the direction in which they want to move, and unwilling to tolerate delays or slow progress.

Gilpatric is reported as a man who works from 7:30 a.m. to 7:30 p.m., seven days a week. McNamara also starts work at 7:30 a.m. but usually does not leave later than 6:30 p.m. Since collapsing from overwork and tension a few years ago, he has attempted to achieve a better mix of work and relaxation.

An area where the two may have differing views is on defense reorganization, one of the most controversial problems facing the new Administration.

Gilpatric, whose appointment was widely forecast, was a member of the committee headed by Sen. Stuart Symington (D.-Mo.) which advocated sweeping changes in the Defense Department, including elimination of the service secretaries and joint chiefs of staff and placing more power in the office of the secretary (AW Dec. 12, p. 34), although he was not among its most active members. He also was named to Kennedy's defense planning group (AW Sept. 5, p. 29).

McNamara visited Rep. Carl Vinson (D.-Ga.) chairman of the House Armed Services Committee last week and told Vinson that he does not plan early reorganization of the Defense Department, but that he will take time first to see what changes are needed. He earlier visited Sen. Richard B. Russell (D.-Ga.) chairman of the Senate Armed Services Committee, in Winder, Ga. Neither McNamara nor President-elect Kennedy has commented on the Symington report other than to say it would be studied, analyzed and considered by both the executive and legislative branches of government before he made his own recommendations.

McNamara, who is not committed to the Symington plan, while Gilpatric's views are known, can act as a buffer between opposing forces and not attempt to submit to Congress or carry out those recommendations facing the greatest opposition until sometime in the future when the groundwork has been laid for easier acceptance.

Democratic Commitment

However, since the Democratic platform is pledged to reorganization of the Defense Department as "a first order of business" (AW July 18, p. 32) the new Administration will be expected to at least make a start along this line, submitting the least controversial recommendations first.

Gilpatric is known to have wanted the top defense post rather than the number two job, but he undoubtedly will have an important influence as deputy on McNamara's decisions because his experience in the defense field is so much broader.

He won the post after a three-way tussle in which he had the backing of Sen. Symington and Kennedy's transition and appointment aide, Clark Clifford. Kennedy's own choice had been Paul H. Nitze, who is president of the Foreign Service Educational Foundation, a former director of State Department's policy planning staff, and an adviser to Kennedy on national security. The third candidate was proposed by McNamara himself, presumably a close business associate.

The new deputy defense secretary's successor as board chairman at Aerospace Corp., a nonprofit organization created early this year as technical manager of Air Force missile and space programs, is expected to be chosen from among three current board members—Trevor Gardner, Roger Lewis and Arthur Raymond. Chalmers Sherwin, another trustee, has resigned from the board to be a full-time staff member, and there is a possibility that the new chairman might be the man who fills Sherwin's spot, although Gardner, Lewis and Raymond are considered better bets.

Gilpatric, a long-time member of the New York law firm of Cravath, Swaine & Moore, joined Aerospace as board chairman in June, presided over the formation of the corporation and picked the top management people. Aerospace Corp. said his resignation is already being processed.

Gilpatric was born in Brooklyn, N. Y., Nov. 4, 1906, and graduated from Yale Law School in 1931. He served as assistant secretary of the Air Force, materiel, in 1951 under Defense Secretary Thomas K. Finletter, and later the same year he was named under secretary of the Air Force, where he served until 1953. He was a member of the Rockefeller Studies Project during 1956 and 1957.

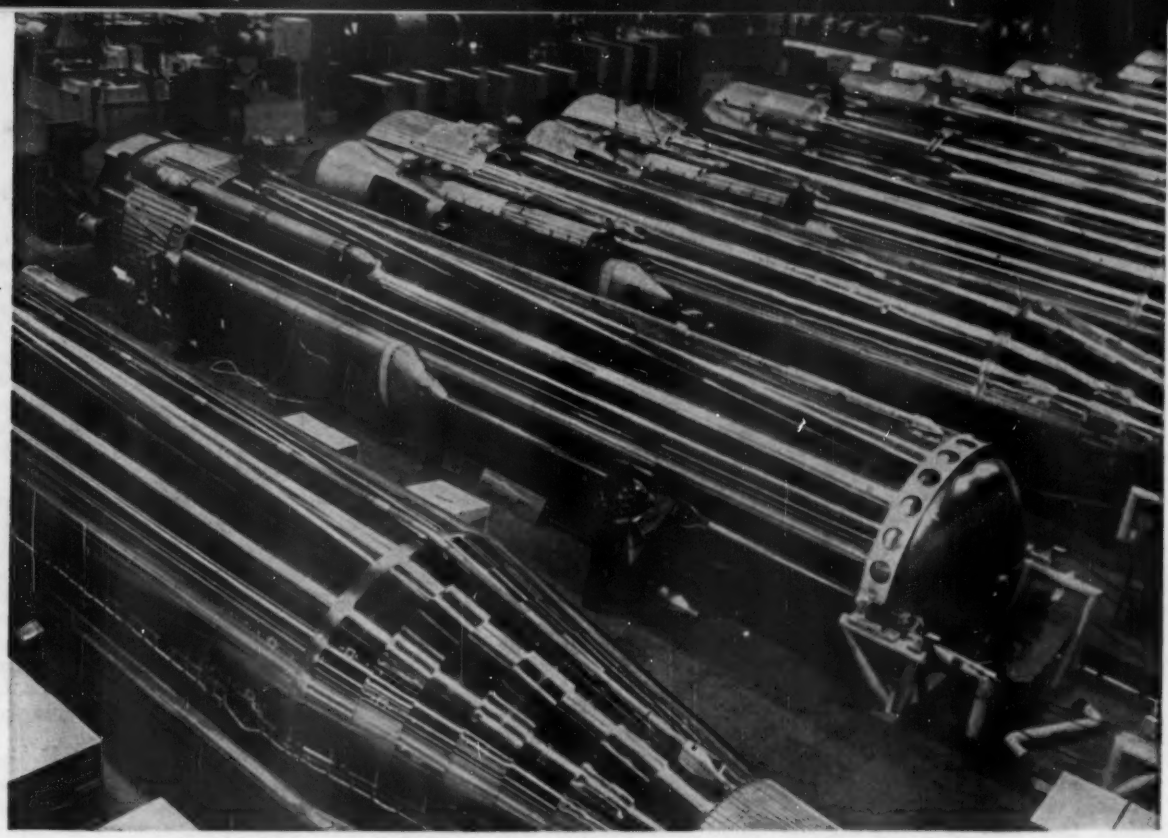
McNamara, meanwhile, completed arrangements to spend full time at the Pentagon between Jan. 1 and Jan. 20, when he will take office. The time will be used in getting acquainted with his new office and in planning the transition. A temporary office will be provided next door to Defense Secretary Thomas S. Gates, Jr., with whom he has already conferred several times during the past two weeks.

After McNamara's visit to Rep. Vinson's office, he told newsmen that all top civilian posts—which would be abolished under the Symington reorganization plan—will be filled by the Kennedy Administration. He said he does not anticipate any reluctance to accept the posts because they might be abolished later, which indicates elimination of service secretaries is not one of the recommendations scheduled for early action.

Prospects for appointment to these posts include Eugene Zuckert, who served as assistant Air Force secretary under the Truman Administration and later as an Atomic Energy Commission member; Phillip P. Ardery, Louisville, attorney and Air Force Reserve brigadier general; Ernest Vandiver, governor of Georgia; and Harold Stuart, assistant USAF secretary under President Truman, and former Air Force Assn. president—all for Air Force secretary. W. John Kenney, Navy under secretary in the Truman Administration and Clarence D. Martin, Los Angeles auto dealer who was Kennedy's campaign coordinator in the West, are candidates for secretary of the Navy.

Franklin D. Roosevelt, Jr., was reportedly vetoed by McNamara for the post of Navy secretary, and James P. Coleman, former governor of Mississippi, declined the offer of an unspecified top Defense post.

Paul Nitze is reported in line for under secretary of defense for international security affairs, a post which is now ranked as an assistant secretary, and Joseph Keenan, AFL-CIO vice president, is being boosted for the post of assistant secretary of defense for manpower.



First Photo of Atlas First Stage for Centaur Vehicle

Atlas first stage for the Centaur vehicle has a rounded nose capping a tank which maintains a full 10 ft. diameter over its entire length. This provides more fuel capacity than the tapered Atlas ICBM tanks shown in other assembly docks at Convair's San Diego plant.

Space Plane Study Contracts Considered

Dayton, Ohio—Requests for proposals for Project Aerospace Plane—formerly known as Project Space Plane—may be issued to industry early next year if an Air Force Scientific Advisory Board ad hoc committee recommends favorable consideration for the project.

This proposed vehicle, which is considered a second- or perhaps third-generation variation of the Dyna-Soar boost glider, would propel itself from the earth into space without a large rocket booster. It would use conventional propulsion systems to reach the fringes of the atmosphere. Then it would propel itself in space by burning liquid hydrogen with liquid oxygen that had been generated on board during very high speed atmospheric flight by gathering very lightly associated molecules of oxygen and nitrogen and compressing them into a fluid state (AW Oct. 31, p. 26).

Two feasibility study contracts probably will result from an industry competition. Applied research probably will get considerable emphasis in these studies. Wright Air Development Division also may conduct some in-house studies.

There were two new developments in the proposed programs at a two-day meeting here earlier this month:

• **Broad requirements** under SR-19786 were outlined by Air Force representatives to top industry executives.

• **Ad hoc committee** was briefed by Air Force and industry representatives on the broad conceptual aspects of a winged vehicle with versatile characteristics in both atmosphere and space, but not necessarily having a configuration or capability which might satisfy specific Air Force requirements.

The Scientific Advisory Board previously had indicated a favorable reaction in a preliminary assessment of the advantages of the potential project, and the recent briefing at WADD was in the nature of a final follow-up.

The meeting included representatives of Air Force headquarters, Air Research and Development Command headquarters, and WADD, which would manage the project if it is officially activated. Industry members included Boeing Airplane Co., Convair Division of General Dynamics Corp., Douglas Aircraft Co., Lockheed's California Division, Republic Aviation Corp., Marquardt Corp., and Pratt & Whitney's Florida Research and Development Center.

Marquardt and P&W would be competitors for development for the basic liquid air cycle engine (LACE) contemplated for Aerospace Plane. Marquardt uses the LACE designation, while P&W refers to its powerplant concept as the high-pressure engine.

At this point, some industry members give Marquardt a considerable edge in the potential liquid air cycle engine development because of its relatively higher mass fraction design parameter. Also, Marquardt had been conducting some study in the liquid air cycle regime under contract to WADD up to about two years ago. Convair is believed to have had a corresponding study contract for the vehicle, but both these studies were downgraded in relative importance until interest by the military in Aerospace Plane gathered new impetus.

Estimates of the time span required to develop a liquid air cycle engine vary, but the consensus of advanced propulsion designers is that it probably would not be longer than that which was expected for the development of the turbojet engine to a high state of reliability.

A vast amount of advanced technology accumulated in the development of various types of air-breathing engines will contribute to basic development of

the liquid air cycle engine, although it is generally agreed in industry that advanced air-breathing engine concepts could have been much further along if acceleration of the state of the art had not been neglected, largely because of the emphasis on missiles.

Funding for initial development of the liquid air cycle engine alone, if Aerospace Plane is underwritten in the Fiscal 1962 budget, is likely not to exceed about $1.5 million for the feasibility-applied research aspects. Air Force had asked approval of $20 million for the project in Fiscal 1962.

A major goal in the design of the liquid air cycle engine will be an operational scheme that makes maximum use of the engine hardware. A multiplicity of propulsion devices to boost the plane from sea level to the fringes of the atmosphere must be avoided because weight will be a most critical factor.

Present projections for development of Aerospace Plane do not relate it exclusively to a specific weapon system concept. A versatile vehicle, Aerospace Plane is expected by military and industry observers to be feasible for as many as 50 missions. Primary use in the foreseeable future would be in earth-centered orbits. While a substantial crew could be accommodated in Aerospace Plane, Air Force stresses payload-carrying potential rather than crew.

Control Study Bids Requested for Saturn

Washington—Proposals for studies to refine Saturn C-1 booster stability and control techniques have been requested by National Aeronautics and Space Administration to advance these concepts beyond the gimbaled-engine control system now planned.

Proposals for the one-year analytical studies are due Jan. 23 at Marshall Space Flight Center. Original Dec. 15 bid deadline was moved back to allow additional proposals to be made.

NASA says the basic purpose of the studies is to improve the state of the art in control and dynamic stability techniques for large vehicles. If a practical new concept is produced, it could replace the present control system on Saturn. Stability problems in Saturn result from its low bending frequency, high dynamic pressure, large wind shear effect, limited control forces and the incomplete knowledge of structural dynamics for a clustered vehicle 185-ft. high and 21.5 ft. in diameter.

Industry studies are to go beyond immediately available off-the-shelf methods of improvement, and they are expected to include proposals for plug nozzles, more advanced methods of gimbaling engines, air vanes, jet vanes and jetevators.

Herter Gives NATO Ministers Polaris, Nuclear Submarine Plan

Paris—Only West Germany warmly received U. S. suggestions, made during the recent NATO annual ministerial meeting, that NATO members buy and jointly control 100 Polaris missiles which would be deployed throughout the NATO area.

The U. S. idea, put forth as a "suggestion" by Secretary of State Herter, also includes a promise that if Europeans accept the idea Washington will commit five nuclear submarines, each equipped with 16 Polaris missiles, to the NATO command.

Moreover, Herter indicated that Washington—assuming its offer to sell 100 Polaris missiles is accepted—"might" reconsider present control arrangements surrounding NATO's nuclear stockpiles.

This latter possibility could prove to be the most important U. S. idea advanced at the NATO meeting. NATO nuclear stockpiles, created as a result of the NATO summit conference in December, 1957, today represent the real strength of the NATO alliance.

Under the stockpile system, nuclear warheads can be given out to NATO allies in time of conflict. This system permits non-American military ground and air units in Western Europe to operate on a "dual-capability" basis.

Today, however, with West German air and ground units taking over the dominant front-line role, this system is becoming somewhat inefficient. Thus West German military commanders are eager for a loosening of the present warhead arrangement under which the U. S. keeps exclusive control. Germans fear that this arrangement, while perhaps efficient for small ground and air units, could not work fast enough when 12 German divisions and a large air force have to draw off a stockpile of warheads in a time of crisis.

German reaction was also favorable to the U. S. idea that European NATO members buy 100 Polaris missiles. Other NATO members, however, were markedly less enthusiastic. NATO observers, in fact, running down the membership list, wonder what other NATO members, besides West Germany, will ever accept the U. S. Polaris suggestion.

France, for example, has all it can do to finance development of its own independent nuclear strike force. The French, moreover, insist they do not intend to substitute their own ambition in this field for a joint NATO deal.

The Italians, under a bilateral deal with Washington, have accepted joint control of Jupiter bases in northern Italy and probably would not want to get involved in the heavy expense of buying more missiles of this type.

Scandinavian NATO members, who plainly want no part of the Polaris program, also are reluctant to see the U.S. give up its exclusive control over NATO's nuclear capability. These nations claim East-West tensions will only increase, not decrease, if nuclear responsibility is shared by Washington.

The Benelux nations, already involved in comparatively heavy defense expenditures for F-104 fighter and Hawk anti-aircraft programs, do not have much money to spare for the purchase of million-dollar missiles.

West Germany, on the other hand, openly welcomed Herter's suggestion. This attitude has reaffirmed the opinion of some observers who feel that the main objective behind various moves to give NATO an increased nuclear capability is a desire on the part of Washington to find a formula to meet increasing West German demands for nuclear hardware for their growing military establishment.

Herter's suggestion that the U. S. is ready to commit five missile submarines to NATO—providing European members of NATO buy 100 Polaris missiles—failed to impress European delegates. It is generally known in NATO military circles that these five submarines, each equipped with 16 Polaris missiles, have long since been slated for assignment to the Sixth Fleet in the Mediterranean. Since Washington has traditionally maintained that the Sixth Fleet is supporting the strike force on NATO's southern flank, most European military officials had the feeling that Herter was offering something NATO, in any case, is going to get.

The U. S. suggestion that Europeans buy 100 Polaris missiles did not contain any precise details on how the missiles should be bought or operated. It was reported, however, that U. S. military officials did informally indicate that such missiles should be deployed mainly on ships, river barges and rail cars. Missiles probably would be controlled under a multi-nation agreement, with missile units presumably being assigned directly to the top NATO military command.

Secretary of State Herter and other members of the U. S. delegation insisted that they were putting forth "suggestions" and not concrete proposals. It was expected that no major decisions on NATO nuclear capability will be made until the new U. S. administration attends the next NATO ministerial meeting, to be held in Oslo next May.

NASA Chooses STL For OGO Spacecraft

Washington—Space Technology Laboratories, Inc., will build three spacecraft for the National Aeronautics and Space Administration's geophysical satellite experiments, to be launched in a program beginning in two years.

The negotiated contract will exceed $15 million, and it is the first systems award made directly to STL by NASA. Earlier STL payload work for the space agency was negotiated through the Air Force Ballistic Missile Division. The STL proposal won over seven others submitted (AW Dec. 19, p. 37).

Orbiting geophysical observatory (OGO) will be the first standard, multipurpose NASA spacecraft to be flown. First flight of the orbiting astronomical observatory (OAO) awarded to Grumman in October will come in late 1963 (AW Oct. 17, p. 30).

The OGO contract calls for spacecraft to be used for these missions:

- **Eccentric geophysical orbiter** (EGO), with a mission target date of January, 1963, using an Atlas Agena B launch vehicle. Payload is designated S-49 and will be programed for an orbit ranging from 170-70,000 mi., essentially designed to study energetic particles at these altitudes.
- **EGO backup,** with a flexible launch date any time from January to September, 1963, with the same launch vehicle and objectives as the primary experiment.
- **Polar geophysical orbiter** (POGO), scheduled to be launched from the Pacific Missile Range by a Thor Agena B. This payload is designated S-50, and will be used chiefly to study the atmosphere and ionosphere between 170 and 650 mi.

The standard OGO spacecraft will be about 6-ft. long and 3-ft. square. Satellite will weigh 1,000 lb., with a growth potential to 1,500 lb., including a 300-lb. piggyback satellite. Large solar paddles will house cells to provide an average of 50 watts of power for experiments.

Standard package also will include wide band, narrow band and special purpose telemeter systems, and dual stabilization systems using both gas jets and reaction wheels so that the same axis will always point toward the earth.

STL will be responsible for the basic structure, power supply, attitude control and command system. NASA's space sciences steering committee will select the experiments to be packaged in the satellite's modular compartments.

More than 50 experiments can be included in the OGO payload, which will have a structural configuration tailored to the number and disposition of experiments.

Vulcan-Skybolt Mating Project Halted

Washington—Work on adapting the air-launched ballistic missile Skybolt to the British Avro Vulcan turbojet bomber has been halted and apparently won't be resumed unless British funds become available.

Until now, funds for the development work have been provided by the U. S. Air Force.

The entire Skybolt project at Douglas Aircraft Co. has been placed in jeopardy through a financial tangle caused by unauthorized expenditure of funds to keep it going (AW Dec. 19, p. 26). Result has been a sharp cutback for the remainder of the fiscal year, including the Vulcan adaptation.

Skybolt was intended primarily as a standoff missile for the B-52 and later was chosen for the Vulcan. Skybolt is incompatible with the B-70 Mach 3 bomber, which recently has received high priorities, because of the wide temperature regime in which that aircraft will operate. State-of-the-art in solid propellant rockets does not permit operations ranging from sub-zero temperatures while flying at subsonic speed to the high temperatures of Mach 3 flight. Problems arise from expansion and contraction, and burning rate also is affected.

Cutback has caused pulling of 30-50% of the engineers from various sections of the Skybolt project, depending on the particular design section involved. Most of these engineers have been placed on the Douglas portion of the Saturn booster program. When the stretchout was ordered, Douglas had about 1,100 persons working on planning, design, project engineering and engineering schedules.

Slippage due to the stretchout will vary. Some of the schedule targets will fall as much as six months behind. First guided firing has slipped three to four months, but the dummy carry-and-drop program will proceed on schedule, using the Boeing B-52G to test compatibility of aircraft and missile.

Taxi tests of the Boeing B-52G at Wichita carrying the Skybolt dummies were held this month. B-52H, scheduled for initial rollout Jan. 5, was originally intended to have Hound Dog missiles slung under the wings, but plans were changed to call for dummy Skybolt missiles just before the funding problem arose in order to demonstrate the aircraft's ability to carry the new missile.

Constellation Damage Alters Carrier Plans

Washington—Navy has been forced to change its fleet aircraft carrier plans in the wake of a fire last week which seriously damaged the attack carrier USS Constellation at Brooklyn Navy Yard.

Navy estimates it will take about a year to repair the damage and get the Constellation ready for sea duty. The 33,000 ton USS Hancock, scheduled for anti-submarine duty, will remain an attack carrier until the 65,000 ton Constellation can go to sea.

The Hancock will only partially fill the gap left by the fire damage, since it cannot handle the heavy attack aircraft, such as the North American A3J, which will fly from the larger carrier. The change in plans also leaves the ASW forces short a carrier.

Constellation and the similar attack carrier USS Kitty Hawk, now under construction at Camden, N. J., were both scheduled to be commissioned in March and joint the fleet later in the year.

Damage to the Constellation, estimated at $75 million, mainly involves warped decks and bulkheads and destroyed transmission lines for fluids, gas and wiring. Fire started when a welder's torch ignited a pool of spilled diesel oil, and it killed 48 workmen. A Bureau of Ships technical investigating panel is probing possible fire hazards on other ships in construction.

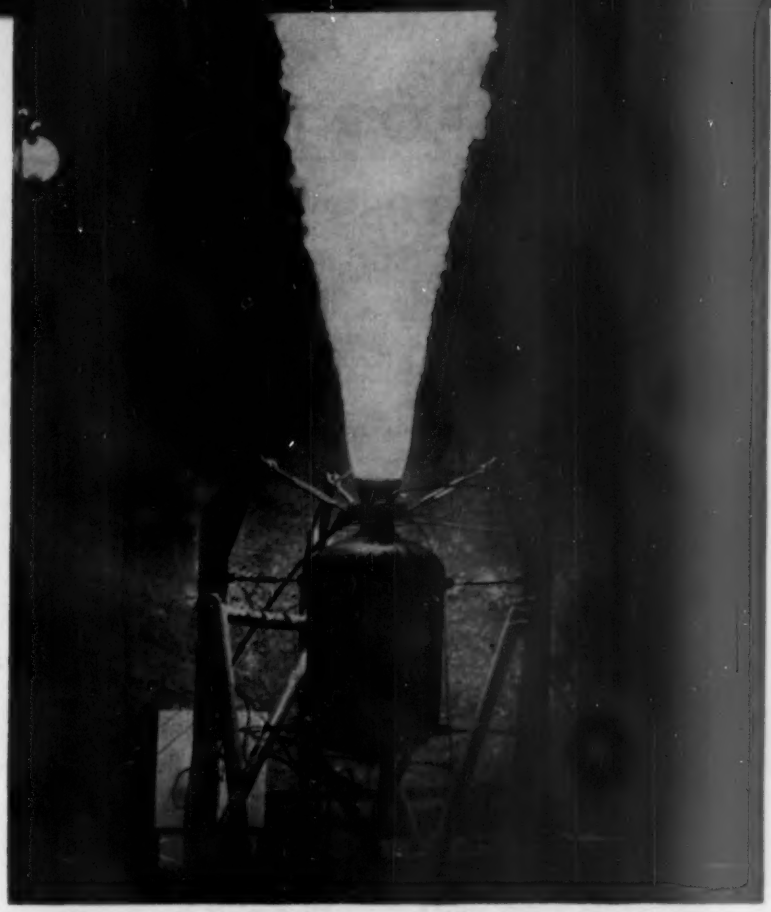
Navy will have to decide whether to take money for the restoration from funds earmarked for other projects in the current fiscal year, or to ask Congress for a supplemental appropriation.

Golden Ram Produces Successful Atlas Shot

Washington—First Strategic Air Command launching of a USAF-Convair Atlas missile from Vandenberg AFB, Calif., under Project Golden Ram was an unqualified success, ending a string of five partial failures in operational training shots of the missile.

The Atlas-D, fired Dec. 16, delivered a General Electric Mark 3 nose cone 4,384 naut. mi. into the Eniwetok Atoll in a test of the warhead's arming and fuzing mechanism. A small charge of TNT carried in the nose cone detonated on target in a surface burst over a specially instrumented area of the lagoon.

USAF undertook Project Golden Ram (AW Dec. 19, p. 25) in an effort to tighten operational launch procedures and eliminate the problems that had led to five partial failures since the last successful shot from Vandenberg in April. Contractor crews prepared the horizontal emplacement and the missile, and a crew from SAC's 576th Strategic Missile Squadron conducted the countdown and the launch.



Segmented Solid Propellant Rocket Motor

Three-segment solid propellant rocket motor, developing 15,000 lb. thrust, has been successfully fired in a static test for 50 sec. by United Technology Corp., Sunnyvale, Calif. The motor is the first of three vehicles being built under NASA contract to test the feasibility of the segmented, or building block, concept (AW June 13, p. 28) of solid propellant motors for large booster or upper stage application. The three conical segments are tapered at an angle of 1.5 deg. from a true vertical. Over-all length is about 7 ft.; widest segment is approximately 3½ ft. in diameter.

Britain, France Plan Joint Space Booster

Geneva—British and French governments are considering plans to propose a joint program to supply a booster system to place into orbit payloads developed by the planned common West European space effort. The booster system would incorporate the de Havilland Blue Streak IRBM as the first stage and France's 5,000-lb.-thrust Veronique research rocket as second stage.

Both programs have rolled to a virtual standstill and their acceptance by the European community could give space and missile research in the two countries a needed boost. The basic British booster plan proposed in the past has called for Blue Streak as first stage and the 20,000-lb.-thrust Black Knight as second stage.

The Blue-Streak-Veronique combination would throw French support behind the effort to sell the program as a European space booster, Goeffrey Rippon, British parliamentary secretary to the minister of aviation, told the House of Commons last week. Negotiations between the two governments have established technical feasibility of the project. In a recent organizational meeting of the 11-nation European space group at Geneva, at which Britain and France were represented, delegates decided against any common effort to develop booster systems. It was reported at the time that Britain and France hoped to sell the necessary booster units to other nations involved (AW Dec. 12, p. 29).

French 707 Pilots To Continue Strike

Paris—Air France Boeing 707 pilots voted to continue a strike against management which has grounded the French carrier's entire fleet of 17 Boeing 707-320 jet transports since Dec. 9.

The strike involves only Boeing flights. Air France continues to operate Caravelle jets as well as piston flights. Piston-aircraft pilots, however, are refusing to fly any route normally served by 707s. Air France officials say the strike is costing the carrier $180,000 daily.

The company and the pilots initially reached agreement on the main issue—the number of Boeing flight hours to be flown—but they disagree on the base pay of Boeing flight hours. The difference involves less than 30 cents an hour.

The strike affects most of Air France's international routes.

News Digest

Dr. Herbert F. York will remain as Defense Department's director of research and engineering (AW Dec. 19 p. 25) "for a limited period," Defense Secretary-designate Robert S. McNamara said last week. A defense spokesman interpreted "limited period" to mean six months or more.

Thomas G. Lanphier, Jr., who resigned as vice president of Convair earlier this year to comment on U. S. defense policy has been elected president of Fairbanks Morse & Co. He remains a vice president of the parent company, Fairbanks Whitney Corp.

Los Angeles Airways became the first U. S. scheduled helicopter airline to offer turbine-powered service when a Sikorsky S-62 was put in service Dec. 21 between Los Angeles International Airport and heliports at Riverside, San Bernardino and Anaheim/Disneyland/Fullerton.

Kendrick R. Wilson, Jr. was elected Avco Corp. chairman of the board last week, succeeding the late Victor Emanuel and James R. Kerr was elected president.

Federal Aviation Agency will change the name of its Atlantic City, N. J., facility from National Aviation Facilities Experimental Center (NAFEC) to Bureau of Research and Development Center (BRDC).

Initial delivery of Cessna U-3B, utility version of Model 310F light-twin business plane, will be made to USAF in the last week of December. Cessna has contract for 35 U-3Bs, with deliveries extending through June, 1961.

Aeronutronic Division of Ford Motor Co. was awarded a $3 million Army contract for continued research and development on Shillelagh surface-to-surface tactical missile system.

Peruvian government has placed a $3.3 million order with Cessna Aircraft Co. for T-37 twin jet trainers and parts, for delivery in 1961.

Collision Avoidance Progress Reported

FAA and Bendix brief airlines on current status; flight tests beginning with experimental system.

By Philip J. Klass

Washington—Federal Aviation Agency and Bendix Radio briefed the airlines last week on the current status of air collision/proximity warning system developments at a meeting called by the Air Transport Assn.

Bendix reported that only two weeks before the midair collision Dec. 16 over New York of a United Air Lines DC-8 and a Trans World Airlines Super Constellation, it had made the first successful flight tests of an experimental air-collision avoidance system (AW Feb. 15, p. 67) on two company aircraft.

FAA spokesmen also expressed restrained optimism over the possibility of a cooperative-type infrared proximity warning system which would use anti-collision rotating light beacons now carried on most aircraft.

In an official statement, FAA said that it would be at least several years before a successful airborne anti-collision system could become operational The infrared might be available earlier, but it would be limited largely to fair weather (VFR) operation. A Bendix official told AVIATION WEEK that it probably would be mid-1963 before production quantities of his company's system could be available. Installation on a sufficiently large number of aircraft to make the cooperative-type system effective probably would require at least another six months.

FAA says that partial relief from the collision hazard may come as quickly from some of its other research and development programs. These include the automatic data processing system for traffic control, a three-dimensional radar which can give terminal area traffic controllers information on aircraft vertical separations, and pictorial navigation displays for the cockpit to give the pilot a graphic picture of his aircraft position.

FAA Test Plans

FAA plans to install the experimental Bendix system in two of its Convair aircraft soon for flight tests at its Atlantic City experimental center. This system is expected to undergo about two months of flight tests, intended to prove the basic system concepts and determine what further refinements are needed.

FAA representatives told the airlines that despite the fact that the agency has received about 200 proximity warning/anti-collision system proposals during the past year, relatively few of them are new in concept or feasible for operational use.

One large, reputable company has even proposed the use of a satellite line in a 22,300-mi. synchronous equatorial orbit, which would use radar transponder techniques to determine position of all aircraft within its view and plot potential collision courses.

FAA representatives also reported that they have practically abandoned any hope of coming up with a self-contained (non-cooperative) type anti-collision or proximity warning system.

Results of tests conducted by the Naval Ordnance Test Station at Inyokern, Calif., have largely eliminated the possibility of a self-contained infrared proximity warning system which could operate from radiation produced by aircraft engine heat. The natural infrared radiation might prove adequate for proximity warning between jet aircraft flying at high altitudes, but the available warning time is not sufficient for piston engine and smaller aircraft at low altitudes where IR radiation is more heavily attenuated by moisture in the air.

FAA interest in an infrared proximity warning indicator has now shifted to a cooperative type system which would permit low-cost protection for minimum-equipped aircraft. Measurements indicate that the rotating anti-collision beacon now in widespread use is an effective source of infrared radiation.

This suggests a system in which the anti-collision beacon is modified so that its light is pulsed at a frequency which is proportional to the airplane's barometric altitude. The pulsations would not be noticeable to the human eye, but would enable another aircraft equipped with an infrared scanner to detect the beacon of an intruder aircraft and determine whether the intruder is at or near its own altitude. The equipped aircraft cockpit would then display the bearing of all intruders whose altitude was at or near the aircraft's altitude to alert the pilot.

The cost of modifying existing beacon lights to provide altitude coding is expected to be quite modest, for aircraft operators who cannot afford to install an infrared scanner. This would give aircraft equipped only with a beacon some protection against scanner-equipped aircraft if the latter takes corrective action.

FAA currently has sufficient funds in its Fiscal 1961 budget to explore further this cooperative-type infrared indicator and intends to do so, AVIATION WEEK was told.

FAA Approach

In exploring possible solutions to the anti-collision/proximity warning system problem, FAA has sought to stretch its available funds by investigating a maximum number of promising basic techniques rather than buying a few systems in which a large portion of the money would be spent for hardware. Most informed observers believe that this is a fundamentally sound policy at the present time. FAA funding during Fiscal 1960 and 1961 for this work has totaled about $1 million.

Characteristic of this approach is the FAA support of a project at Sperry Gyroscope Co. Sperry proposed a cooperative type proximity warning/collision avoidance system which would use a K-band radar and transponder techniques. The use of radar has been proposed previously, but it foundered on the question of where the radar antennas could be located to provide necessary coverage.

Sperry proposed to use a flush-mounted luneberg lens type of antenna, giving both omidirectional and scanning type coverage, which could be mounted in the belly of an airplane. The concept was an outgrowth of the company's work in rendezvous radar for use by Strategic Air Command bombers and tankers.

After analyzing the Sperry proposal, FAA concluded that the feasibility of the approach hinged on the ability to obtain the required coverage and target bearing resolution accuracy with a flush-mounted antenna, according to James H. Muncy, acting chief of Bureau of Research and Development's collision prevention section.

FAA therefore funded a program with Sperry to evaluate the suitability of this flush-mounted antenna. Flight tests are scheduled to start early in 1961 at Atlantic City, according to Philip J. LaRochelle, assistant section

chief at the bureau. If the antenna feasibility is established, FAA is likely to fund additional effort on the Sperry system approach.

Within the next several weeks, FAA expects to receive a cooperative-type PWI system, developed by Motorola, which will be flight-tested at Atlantic City. The system is viewed more as a tool for studying the usefulness of a proximity warning system as an anti-collision device rather than as the prototype of an operational system.

A Radio Corp. of America weather radar with a proximity warning adapter, which has been undergoing flight tests for some months aboard a United Air Lines Convair 340, reportedly has performed well at high altitudes. At lower altitudes, its useful range is limited by ground reflections. A study to determine the possibility of a basically new airborne radar, specifically designed to perform weather, terrain and proximity warning, may be funded by FAA.

Within two months, FAA hopes to begin carefully controlled tests to evaluate the usefulness of a proximity warning system in avoiding collisions and the optimum cockpit instrumentation for displaying PWI information to the pilot. Tests will be conducted using an Air Force aircraft gunnery simulator at Atlantic City.

A variety of collision and near-collision situations can be projected on a hemispheric screen surrounding the aircraft simulator to measure a pilot's ability to detect intrusions, assess their hazard and take required evasive action in time. Through the use of this ground simulator, FAA hopes to obtain considerably more factual data than previously has been available.

FAA is continuing its investigation of techniques for making aircraft more conspicuous in flight by means of fluorescent paint and external lighting. Under FAA contract, the Applied Psychology Corp. is using realistic simulation techniques to determine what visual aids can be used to decrease the collision hazard in VFR weather conditions.

Crash Stirs New York Air Traffic Probe

New York—Civil Aeronautics Board investigators of the fatal midair collision and crash of two airliners here Dec. 16 are taking a broad look at air traffic control procedures and facilities in this high-density area, with particular regard to their adequacy to integrate jet aircraft in bad weather.

The crashes of a United Air Lines Douglas DC-8 jet into densely populated Brooklyn and a Trans World Airlines 1049A Constellation on Staten Island took at least 133 lives and have touched off a controversy involving Federal Aviation Agency chief Elwood Quesada.

Among the points of careful scrutiny are reports that an omnirange, upon which the DC-8 pilot depended to fix his holding position in the area, had been the target of pilot complaints during the day the accident occurred. The UAL plane, 11 mi. from where it should have been, collided with the Constellation in rain and fog over Staten Island.

The DC-8, Flight 826 out of Chicago, was cleared to Preston Intersection, where it was to enter a holding pattern and await clearance for its approach to Idlewild. The TWA plane, Flight 266 from Dayton via Columbus, had been cleared from Linden to descend to 1,500 ft. for its ILS approach to La Guardia Airport.

The midair collision occurred at a point about 11 mi. north of the Preston Intersection.

The DC-8 carried 77 passengers and a crew of seven; there were 30 passengers and five crew on the Constellation. At least five persons were killed in Brooklyn.

The transcript of the conversation between the two pilots and radar controllers in New York Center and La Guardia and Idlewild Approach Control rooms during the minutes preceding the crash did not explain why the DC-8 apparently overshot Preston Intersection. But it did add these significant details to the official record:

• **United's jet,** crippled by the collision, flew along the localizer course to La Guardia Runway 4 before crashing in Brooklyn. As the plane approached the airport's ILS outer marker, it was watched on radar by both La Guardia and Idlewild Approach Controls. Neither could establish radio contact with the pilot of the descending plane.

• **Glide path** of the La Guardia ILS, which would have informed inbound pilots of their altitude as they descended along the localizer course to Runway 4, was out of service at the time of the crash. Moreover, La Guardia's precision approach radar, which also furnishes altitude information, was inoperative. Thus controllers at the airport, during the emergency, had no means with which to measure the altitude of planes in their control zone.

• **TWA's Constellation** was not instructed to hold in the Linden pattern. Working with La Guardia Approach Control from the time he passed over the Solberg VOR at 9,000 ft., the TWA pilot was instructed to slow his aircraft to approach speed (about 130 to 140 kt.) and to maintain present heading of about 100 deg. for a radar vector to the La Guardia final approach course.

• **Approaching Linden,** the TWA flight was instructed to turn right to 130 deg., a turn in the general direction of the Preston holding pattern. Seconds later, La Guardia Approach radioed, "Make that further right, one five zero." It followed this transmission with a warning that a northeastbound plane was six miles away and off the Constellation's right wing tip.

• **Last clearance** acknowledged by TWA was to descend to 1,500 ft. and to turn back to 130 deg. The controller then said, "That appears to be jet traffic off your right now, three o'clock, at one mile northeastbound." As the controller stopped speaking, according to the transcript, a "noise similar to that of an open microphone was heard for approximately six seconds duration." No other transmissions were received from the Constellation.

• **United's jet** was at 14,000 ft. when it crossed Victor Airway 433, about 21 naut. mi. from Preston Intersection. It had been cleared to Preston, to maintain 5,000 ft., and advised that the only delay en route would be in descending. Asked whether he could cross Preston at 5,000 ft., the United pilot replied, "Er, will head it right on down, we'll dump it." At 400 kt., the jet would have traveled the 21 naut. mi. to Preston in 3.2 min., at 300 kt. in 4.2 min. and at 200 kt. in 6.3 min. At this point, the pilot had two options: he could

Flight Voice Recorder

Washington—Federal Aviation Agency plans to require installation of flight voice recorders on all airline transports as an aid to aircraft accident investigation. Reviewing events which preceded the midair collision of a Trans World Airlines Super Constellation and a United Air Lines DC-8 over New York, Administrator E. R. Quesada said he was "convinced" of the need for such equipment.

Evaluation of various types of audio recorders available for use is being completed by the agency's research and development division, and a new rule requiring their use in the cockpits of commercial transports will be issued soon, Quesada said. Air Line Pilots Assn., has endorsed FAA's plans for the recorders but wants any rule adopted to require their installation in the passenger cabin area as well as in the cockpit.

have slowed his aircraft to a speed that permitted gear extension or inboard engine reversing and then started his descent, or he could have nosed the aircraft over and descended at the aircraft's redline airspeed. Both techniques would achieve approximately the same rate of descent.

• **New York Center radar** last advised the United pilot of his position when he was 2 mi. from Victor Airway 433, and less than 24 mi. from Preston. As the jet reported leaving 6,000 ft. at 10:33 EST, the Center instructed the pilot to contact Idlewild Approach Control and reminded him of his holding instructions at Preston.

• **At 10:33 and 28 sec.,** the jet's pilot made his first and only call to Idlewild Approach, "Approaching Preston at 5,000." Five seconds later, Idlewild replied with an instruction to maintain 5,000, a summary of the latest weather at the airport and a report that "little or no delay at Preston" could be expected.

• **Collision occurred** between 10:33 and 28 sec., when the jet pilot believed Preston was still in front of him, and 10:34 and 41 sec. At this time, a La Guardia Approach Control official, speaking to Idlewild Approach Control on a direct telephone line, said: "I think we have trouble here with a TWA Connie. There's something wrong. He's not moving or anything. He might have got hit, uh, by another airplane." Crash site was 11 mi. northeast of Preston intersection.

Engine Found

Investigators found the jet's No. 4 engine near the wreckage of the Constellation, which fell on Staten Island near the Army's Miller Field. Preliminary indications are that the jet's engine struck the cabin of the Constellation slightly aft of the trailing edge of the right wing. Cabin fragments from that area of the cabin were found in the engine pod. Part of the jet's right wing and right aileron also were in the area of the Trans World wreckage.

The controversy following the accident broke out after Quesada held a press conference following his personal report to President Eisenhower on the crash. The FAA chief identified the collision site, asserted that the jet was 11 mi. off course and the TWA plane precisely on course, and said the jet had reported that one of its two omni receivers was inoperative. Loss of one omni receiver, he pointed out, should not have caused the plane to get off course.

Quesada's public discussion of these factors brought the following reactions:

• **G. Joseph Minetti,** member of CAB, pointed out that the Board has the statutory responsibility to investigate accidents involving civil aircraft and that findings will be issued after investigation is completed and all the evidence evaluated.

• **Whitney Gillilland,** CAB chairman, refused to participate in Quesada's press conference on the grounds that CAB couldn't discuss the accident until the investigation has been completed.

• **Clarence N. Sayen,** president of the Air Line Pilots Assn., called Quesada's statements "irregular and improper." Investigation has scarcely begun, Sayen said, and statements at this time which even infer that certain events led to to the accident are "sheer speculation." FAA is one of the parties involved in the accident since it installs and operates navigation, communication and traffic control facilities and promulgates rules, Sayen said, and FAA is an interested and involved party. CAB has the responsibility of investigating the accident and fixing its probable cause, Sayen said, and Quesada's statements ". . . must be viewed as an irregular abuse of public office and it is hoped that the practice will be immediately terminated."

• **United President W. A. Patterson** said "we have always considered it out of order" in accident investigations to issue public statements "until the facts are known." CAB has the responsibility and authority to investigate accident causes, Patterson said, and both United and FAA "are jointly and severally accountable to the CAB for their actions and participation in the conduct of our New York flight." Quesada's statements, Patterson said, left the impression that the flight was carelessly operated and that there was a disregard of instructions from the FAA. "We cannot permit such an impression to exist," Patterson said, and asked three questions of Quesada: (1) Was the Preston signal operating normally or were there reports of malfunction? (2) Did the area radar control center discontinue surveillance of the UAL trip and the Idlewild center then, as prescribed, pick up the surveillance? (3) Under the circumstances, was there any way in which the pilot could determine the malfunctioning of the Preston signal without the aid of radar surveillance in time to offset eleven miles of course?

Quesada answered Patterson's specific questions by letter, and in effect answered other criticism as well. Regarding the questions, the Federal Aviation Agency chief:

• **Denied reports** that Preston signals were not operating correctly in clear weather two hours after the accident. He said FAA heard two rumors indicating malfunctions but they were not confirmed. He said a flight check of Colts Neck omni and check of the flight transcripts indicated the rumors were untrue.

• **Asserted that under** proper procedures approach control radar at Idlewild would not pick up radar surveillance until the flight was ready for release from its holding pattern and being given directions to the ILS. Idlewild was prepared to do so, he said, but could not locate the jet in or near Preston and obviously did not track it. He added there is no prescribed requirement for Idlewild Approach to immediately pick up radar coverage from air route control center.

• **The third question,** Quesada said, is based on the incorrect assumption that Preston was not operating correctly.

Regarding his release of information, Quesada said his statements to date concern "elemental facts" which should not be suppressed, "particularly where there is such a legitimate basis for public interest and press inquiry." He also said FAA must act to determine if any prompt safety measures are required and must react quickly to see if any safety violations have occurred.

CAB Probe

CAB's investigation of the traffic control situation around New York will include use of a United DC-8 which will fly the routes and patterns involved in the accident, AVIATION WEEK has learned. If the agency finds a situation that calls for a change in procedure, immediate recommendation will be made to FAA without waiting for the official investigation to be concluded.

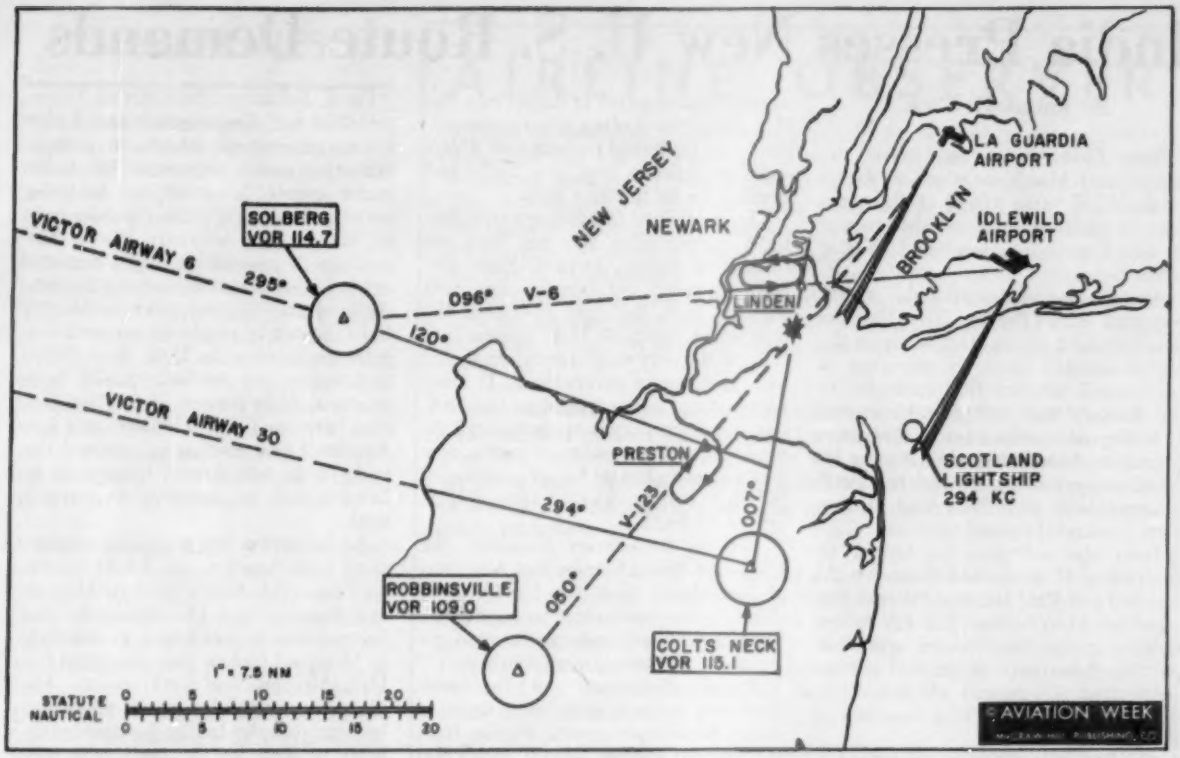
Patterson's questioning of the operation of the "Preston signal" apparently refers to the Colt's Neck omni station, one of the transmitters providing a fix at the Preston intersection.

According to a source close to the investigation, at least four pilots may have complained during the day of the accident that this omni was unreliable. There was investigation of reports that flags went up on omni receivers, indicating inoperativeness of the instrument or of the ground station; of fluctuations of the signal; and, in one instance, an indication of being over the station when a plane actually was north of it.

One DC-8 Omni Out

One of the two DC-8 VOR navigation receivers on the United DC-8 was inoperative prior to the collision, a fact which pilot had reported via company radio when aircraft was about 70 mi. out, but which was not known to FAA traffic controllers at the time.

This would complicate the pilot's procedure in fixing his position and progress along Victor 123 toward Preston, but the single receiver could have been switched to a second VOR station for the fix.



SIMPLIFIED NEW YORK area chart shows where United's DC-8 and TWA's Constellation collided over or slightly northwest of Miller Army Air Field on the east coast of Staten Island. The United jet had been cleared to hold at Preston, a VOR intersection formed by Victor Airway 123 and either the 120 deg. radial of the Solberg omnirange or the 346 deg. radial of Colts Neck omnirange. TWA's Constellation, then near the Linden intersection, had been given a heading of 130 deg. by La Guardia Approach Control radar, a heading that would intercept the ILS localizer course to Runway 4 at the airport. TWA's aircraft was descending from 5,500 ft. to 1,500 ft., while United's jet had been instructed to maintain 5,000 ft. at Preston. The racetrack holding pattern at Preston technically is 16 stat. mi. long and 8 stat. mi. wide. However, its elliptical course is surrounded by a buffer zone that is 4 mi. wide on either end, 5 mi. wide on V-123 and 3 mi. wide to the east.

One of these reports was made by the pilot of an American Airlines jet trainer, who had been flying in the Preston area two hours after the crash and reported a malfunction of the Colts Neck omni.

The Preston holding pattern has been questioned previously as being too close to the Linden pattern. At local meetings with VOR traffic control, ALPA representatives complained of this proximity.

The Preston pattern is a right hand pattern and the Linden pattern left hand, so that aircraft turn away from each other in holding on their respective intersections in the two patterns. Nevertheless, only 5.5 mi. separate the patterns at their maximum degree of proximity.

United Air Lines stopped using the Preston pattern immediately after the crash and now gets alternate routings. American Airlines also has stopped using Preston, calling the move purely precautionary. TWA, on the other hand, continues to use the pattern and said it will continue to abide by the procedures and control instructions issued by FAA, which has the responsibility to develop air traffic control facilities, procedures and en route control of all air traffic.

The Linden intersection actually made its first appearance on (Jeppeson) charts used by both United and TWA at 000 hr. on Dec. 15, about 35 hr. before the collision. Pilots could have picked up the charts a week in advance. Some pilots had been refusing clearance to Linden before the crash on the grounds that Linden was unmarked on their charts.

Maximum speed of all piston transports in the New York control area is 160 kt., fixed by FAA. No maximum speed for jets has been set by the agency, but most carriers' operating manuals, which are subject to FAA approval, call for a jet holding speed of 180 to 200 kt.

Winds aloft at the time of the accident were, at the 5,000-ft. level, 210 deg. at 20 kt., which would give the United jet a tailwind as it turned toward the Preston intersection from eastbound airway V-30 onto the northbound V-123.

The flight recorder recovered from the wreckage of the DC-8 was expected to provide, for the first time according to CAB, an accurate record of operation during the last phase of the flight. This Waste King Disposal Co. instrument records five parameters of flight: heading, time, altitude, speed, and g forces or acceleration. The case of the DC-8's recorder was badly damaged and burned and the last 15 min. of the tape was gummed with burned insulation material.

The tape last week was being soaked to remove this material and it was believed the tape would be the cleanest record to date in such cases. The recorder was carried to Washington by a CAB investigator and turned over to the Bureau of Standards, where it remained as of last mid-week.

CAB has put together the largest group it has ever assembled in an accident case to handle the investigation. Under Melvin N. Gough, new director of the Board's bureau of safety, the group has been split in two teams to cover each of the crashes. Philip Goldstein is over-all director of the two teams, with George van Eppes of New York handling the DC-8 phase of the investigation and George Clark of Ft. Worth covering the Constellation.

India Presses New U. S. Route Demands

By Robert H. Cook

New Delhi—India will renew demands next March for more air routes to the U. S. while trying at the same time to retain its limits on the amount of service to India permitted U. S. flag airlines.

Air - India International, newly equipped with Boeing 707-420s, has now become a competitive factor on the routes awarded India six years ago in an unusual bilateral that conceded to the Indians the authority to restrict U. S. flag carrier frequencies. Now there is pressure to add Honolulu to the Indians' transpacific route and to extend it across the U. S. to New York to complete a round-the-world network.

India also will press for further restriction of U. S. carriers—Trans World Airlines and Pan American World Airways—operating there. The key to settlement of this issue lies in agreement on interpretation of traffic volume studies to determine whether U. S. flag traffic is largely Third Freedom or Fifth Freedom.

The point of contention is the passenger traveling on a U. S. carrier who stops en route between the U. S. and India. The Indians argue that he is Fifth Freedom traffic, which is traffic boarded in a third nation and carried to India. The U. S. carriers argue that he is Third Freedom traffic, which is traffic originating in the U. S. and terminating in India. Since flight frequencies are based on Third Freedom traffic volume between the two nations, this is a crucial interpretation.

Negotiations Requested

These arguments arise because the Indian government asked early this year to reopen the bilateral agreement to discuss changes. Inconclusive discussions were held in October, and they will be resumed in March. Along with their campaign against U. S. carrier flight frequencies, the Indians want Honolulu added to the route they now have between Tokyo and San Francisco or Los Angeles. They also want this route extended to New York to link with their transatlantic routes and a new polar route from both California cities to London, another junction point with present Air-India routes.

State Department says the Air-India transpacific routing has generally been agreed to in the past, but the addition of Honolulu is an entirely new issue. State also says it has been understood that the Indians could use either San Francisco or Los Angeles, but not both as they now demand.

Air-India has the authority to operate an unlimited number of flights into the U. S., but the Indian government restricts the combined frequency of TWA and Pan America into New Delhi and Bombay to six flights a week.

The frequency freedom granted Air-India several years ago has been accorded all foreign carriers, State Department points out, but the agreement allowing India the right to control the number of flights of U. S. carriers into India is the only such stipulation signed with any foreign government. It came six years ago when service to the U. S. was not immediately contemplated by Air-India, and a number of routes were granted in exchange for an increase of the flight frequencies then allowed U. S. carriers in India.

The six frequencies permitted the U. S. into India, four by Pan American at New Delhi and two by TWA at Bombay, are insufficient to handle the heavy volume of American travelers going there, the two carriers contend.

Americans account for the overwhelming majority of airline tourists to India, the airlines report. Figures from the Indian Tourist Bureau show that 21,707 Americans flew to India last year, compared with 16,875 from the United Kingdom, 2,153 from France and 868 from The Netherlands. In the previous year, an estimated 18,000 Americans flew to India but only 5,100 traveled by U. S. flag carriers, which were limited to only five flights a week. A majority of the rest flew on Scandinavian Airlines System and British Overseas Airways Corp. In the same year, only 4,476 Indians traveled to the U. S.

The acquisition of Boeing 707-420 turbojets by Air-India, along with the airline's operational freedom into U. S. cities and its pooling arrangement with BOAC and Qantas Empire Airways, is causing deep concern on the part of TWA and Pan American, who view this combination as a powerful competitive threat. Air-India now has three 707s, expects a fourth by spring, and hopes to purchase two more. The carrier can be expected to increase its present frequency of three weekly flights between Bombay and New York via London. The Indian carrier also has two other direct Bombay-London flights a week.

Another point of contention between the negotiators will be the high frequencies permitted British Commonwealth carriers into India. BOAC and Qantas, which share a pool arrangement with Air-India, have a total of 21 frequencies a week, compared with the six flights for U. S. carriers and an average of only two for carriers such as KLM and Lufthansa.

Dr. P. Subbaryan, Minister of Transportation and Communications of the Indian government, objects to charges that the routes requested by India would eventually result in Air-India carrying an excess of Fifth Freedom traffic, and he told AVIATION WEEK that granting of any further flight frequencies to U. S. carriers depends on the outcome of the bilateral talks in March. India definitely wants to inaugurate a polar service from the U. S. West Coast to London, and Air-India would have an initial flight pattern of two flights a week between Tokyo, Honolulu and Los Angeles if that routing is approved, he said. In the near future, frequencies to London will be increased to seven a week.

Air-India also has a pooling arrangement with Aeroflot, the Soviet carrier, for two weekly flights between Moscow and Bombay, and Dr. Subbaryan said his government had hoped to negotiate a Moscow-London link to permit a Delhi-Moscow-New York service. The idea was rejected by Soviet negotiators last year, but the Indian government expects to press for the route next year.

B. R. Patel, vice chairman of the Air-India board, views the India-U. S. bilateral talks as a simple matter of "give and take" on both sides. He contends that 99% of the total traffic carried by American carriers to India has been Fifth Freedom, since "Americans are the only world travelers" who can afford to stop at several points on vacations.

Traffic Count Dispute

Origin and destination figures, taken from airline tickets and submitted by the U. S. carriers, have never been used by India for traffic studies, he said, and do not give a fair picture of the amount of Fifth Freedom traffic carried by these airlines. Detailed figures reflecting the actual number of passengers who use stopover privileges en route to India would reveal the U. S. carriers as handling an excess of Fifth Freedom traffic to India, Patel maintains.

Replying to charges that the Indian government has failed to submit the necessary traffic figures needed to conclude any further bilateral talks, Patel replied that although Air-India has only been operating into the U. S. for the past eight months, it could "immediately" submit the proper figures but would insist on submitting a second set of origin and destination figures "to match theirs." Requests by Air-India that the U. S. carriers supply figures reflecting the actual volume of "stopover" passengers have been rejected, he said, on grounds that such an undertaking would be too costly.

SHORTLINES

▶**American Airlines** posted a 10% increase in November air freight revenue ton miles over traffic the same month last year. Freight ton miles carried last November totaled 9,823,000.

▶**British Overseas Airways Corp.** has scheduled introduction of Boeing 707-420 turbojet service on its European and Middle East routes for Jan. 30. BOAC will offer twice weekly round trips from New York to London, Geneva, Tel Aviv and Teheran. Along with transatlantic flights, the carrier currently is offering daily Boeing 707 service from New York to Nassau in addition to its daily Britannia service.

▶**Export-Import Bank** of Washington and the Development Loan Fund have allocated $2.6 million to help pay the costs of modernizing Lod International Airport at Tel Aviv, Israel. Of this total, 2 million Israeli pounds—about $1.1 million—repaid to the Development Loan Fund on previous loans will be reloaned. The remaining $1.5 million will be in U.S. dollars.

▶**Federal Aviation Agency** has established an Interagency Group on International Aviation (IGIA) to coordinate U. S. decisions on international aviation matters and make recommendations to the State Department. FAA administrator and the Departments of State, Defense and Commerce and the Civil Aeronautics Board will be represented.

▶**Northeast Airlines** has increased its Boston-Washington nonstop flights from six to eight daily. The carrier operates a total of 27 flights between the two cities, 19 of which stop at New York or Philadelphia. One flight each way originates or terminates at Montreal, giving the Canadian city single-plane service to Boston and Washington.

▶**Qantas Empire Airways** is delaying departures of late evening flights from San Francisco until one minute after midnight to give passengers the full benefit of 17-day excursion tickets for San Francisco-London trips by giving them an extra day.

▶**Trans World Airlines** has received Civil Aeronautics Board permission to suspend its cargo and mail service to and from Gander, Newfoundland, on transatlantic flights from Dec. 27 through May 1, 1961, due to a drop in cargo and mail traffic there during the winter season.

AIRLINE OBSERVER

▶Domestic trunkline traffic declined sharply in November, giving further indication that 1960 net earnings of the 12 trunklines may fall below the $4 million mark as first predicted by AVIATION WEEK (AW Nov. 21, p. 35). The 3% drop in revenue passenger miles during the month depressed the industry's monthly load factor to 54.39%, the lowest level reached in recent years. Available seat miles continued to climb, but the industry held the rise to an insignificant 1.7%. Meanwhile, coach traffic continued to make deep inroads into first class traffic, a trend that was highlighted early last summer when coach first provided more than half of total traffic (AW July 18, p. 39) and one that is expected to cut into gross revenues for the year.

▶**American Airlines has conducted studies of the Boeing 727, Sud Caravelle and the de Havilland 121 Trident for short-range operations. American now feels, however, that the Convair 990 turbofan transport which it has on order may have short-range capabilities better than those originally estimated, and this may eliminate the carrier's requirement for a new short-range transport.**

▶Civil Aeronautics Board was the last major government agency to receive copies of the United Research, Inc., report on competition between U.S. flag carriers, released earlier this month by the White House (AW Dec. 19, p. 40). CAB officials were unable to lay hands on a copy of the report until four days after the White House released it. The report was sent to the White House last month, preceding the arrival of the Board's Transpacific Route Case decision.

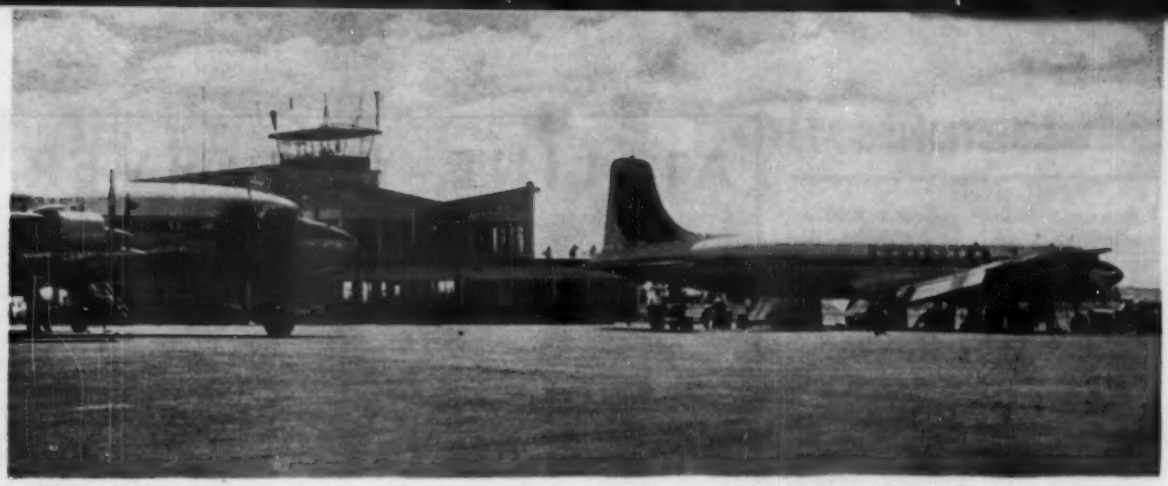
▶**Trans World Airlines has conducted a survey to determine the foreign travel traffic potential from Europe to the U. S. Survey showed that U. S. visa restrictions are the greatest deterrent to foreign tourist travel to the U. S. from Italy, Portugal, Greece, Spain and Israel. Spanish travel would increase an estimated 25% if red tape and delay in securing U. S. visas were eased, the survey concluded. Volume of British and German tourists increased 20% and 25% respectively last year, but TWA found that most travelers from these countries found the U. S. too expensive for touring. Switzerland suggested the establishment of hostelries in the U.S. similar to those in Europe.**

▶Allegheny Airlines has applied to the Civil Aeronautics Board for a helicopter route serving the Washington, D. C., airport complex. Earlier, the Board announced it would investigate the need for scheduled helicopter operations between Washington and the three airports serving it (AW Dec. 19, p. 49).

▶**Japan Air Lines will revise a forecasted $2.5 million deficit for the fiscal year ending Mar. 31, 1961, to a $700,000 net profit. Seijiro Yanagita, the airline's president, attributed the switch from a loss to a profit to the success of the carrier's fleet of Douglas DC-8 jet transports.**

▶Technical agreement has been reached with Britain on a compatible system of side-lobe suppression for radar traffic control beacons, after more than a year of tests and discussions. U.S. domestic airlines will be able to use the single-mode three-pulse technique, while international carriers will carry dual-mode beacons which also accommodate British two-pulse technique. New dual-mode compromise will be proposed as an international standard to International Civil Aviation Organization.

▶**Civil Aeronautics Board Examiner Joseph L. Fitzmaurice denied last week Qantas Empire Airways' request that he press the State Department for an official interpretation of the U.S.-Australia bilateral to determine whether it authorizes Tahiti as a stop on Qantas' transpacific route. Fitzmaurice then asked the bureau counsel to get the information for the record in the case involving this issue. State Department told South Pacific Air Lines last month that notes and records of the U.S. bilateral negotiating team showed no separate agreement making Tahiti an intermediate Qantas stop. State later decided its records indicate an informal understanding was reached, giving Qantas rights at Tahiti.**



TWO Ethiopian Airlines Douglas DC-6Bs are shown on ramp before terminal building at Italian-built Addis Airport.

Ethiopian Airlines Forges African Link

By Robert E. Farrell

Addis Ababa, Ethiopia—Ethiopian Airlines, currently winding up its fifteenth year of operation and its seventh consecutive profitable year without subsidy, is following an expansion program aimed at making the state-owned airline the leading carrier of independent Africa.

Inauguration Nov. 8 of first transcontinental one-carrier service between east and west African coasts marks the latest step in Ethiopian Airline's transition from a regional to an international airline. Carrier now serves 11 countries in Africa, western Europe and the Middle East. It now operates over a network of 16,000 unduplicated route miles. New routes within Africa are being planned as well as introduction of jet equipment early in 1962.

Since its creation in December, 1945, the carrier has been operated by Trans World Airlines under a management contract. TWA's mission has been to establish and operate a profitable airline as well as to train Ethiopian personnel. Currently, about 80% of the carrier's 900 employes are Ethiopians. All top management jobs, however, are still held by TWA executives. Latter are paid by Ethiopian Airlines. TWA has never held any stock interest in the African carrier.

Ethiopian Airlines' route structure is broken into three main segments:

• **Domestic and Middle East.** Some 32 points are served within Ethiopia, a country ringed with deep canyons and high, inaccessible plateaus. Scheduled service is operated also to Djibouti, French Somaliland, to Hodeida and Taiz, in Yemen, and to Aden. Four DC-3s, three C-47s and two Convair 240s are operated on this segment.

• **Africa-Europe.** This segment stretches from Nairobi, in Kenya, some 700 mi. south of Addis, on through the Ethiopian capital to Asmara, in northern Ethiopia, then on to Cairo, Athens and Frankfurt. Carrier holds Fifth Freedom rights all along this route. DC-6B aircraft, of which the carrier has three, are used.

• **Trans-Africa.** Newly inaugurated route runs some 3,500 mi. across the horn of Africa from Addis to Monrovia, Liberia. Flight goes via Khartoum, Sudan; Lagos, Nigeria; and Accra, Ghana. Weekly service is operated with DC-6B aircraft. Carrier holds Fifth Freedom rights along the route.

Biggest revenue earner among these three main routes is the Africa-Europe segment. Carrier operates three DC-6B flights weekly to Frankfurt plus an additional two DC-6B flights terminating at Athens. Flight between Addis and Frankfurt takes about 16 hr. Carrier presently is not pushing expansion on this route. In fact, it cut back Addis-Frankfurt frequency from four flights weekly to three in order to shake loose DC-6B equipment for its new trans-African route.

Opinions vary among Ethiopian Airline officials as to how long it will take before this trans-African route becomes profitable. Yet there is no disagreement that the carrier's main expansion effort will be pushed within Africa. For political reasons, the Ethiopian government is anxious that its airline play an important communications role linking the newly independent African nations. During the Congo crisis, for example,

PASSENGERS are seen boarding an Ethiopian Airlines DC-6B at Khartoum, Sudan, for last leg of flight from Accra to Addis Ababa.

the government ordered the carrier to use its entire fleet on Congo airlift operations.

Inauguration of the carrier's trans-African service on Nov. 8 stems largely from a resolution passed last June by the Conference of Independent African States. Meeting in Addis, the new African governments agreed to hasten development of airline service between their countries. African leaders resent the idea that many air links between their new nations must be made via former colonial capitals in western Europe. Ethiopian Airlines, as Africa's largest carrier owned by an "African government," understandably wants to play an important role in meeting this new demand.

Trans-African Route

Airline's trans-African route between Addis and Monrovia, Liberia, is scheduled to take about 19 hr. Passengers leave Addis at 5:30 p.m. local time and arrive at Roberts Field, some 50 mi. from Monrovia, at 8:00 a.m. the following morning, local time.

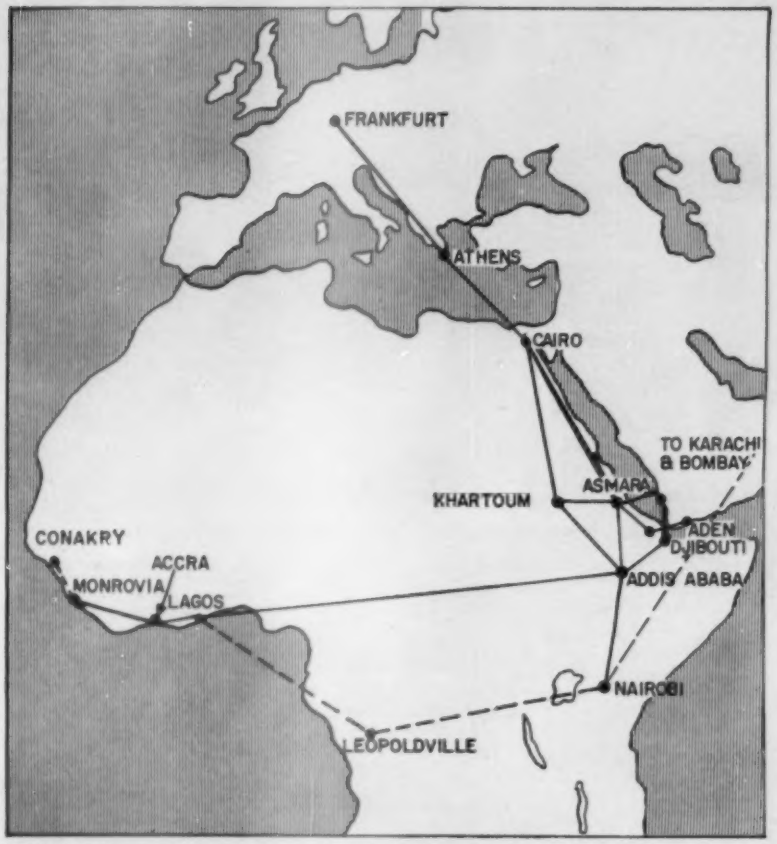
En route stops are made at Khartoum, in the Sudan, at Lagos, Nigeria, and at Accra, Ghana. Carrier enjoys full Fifth Freedom rights along the route. Final details, however, have not yet been worked out between the Ethiopian and Nigerian governments over Lagos stop.

Thus when AVIATION WEEK participated in the first scheduled flight on Nov. 8, Lagos was overflown. This made the longest leg—between Khartoum and Accra—some 2,050 mi. Leg was flown in 8¼ hr. at altitude ranging between 12,000 to 14,000 ft. Aircraft grossed 99,238 lb. out of Khartoum and touched down at Accra grossing 80,608 lb.

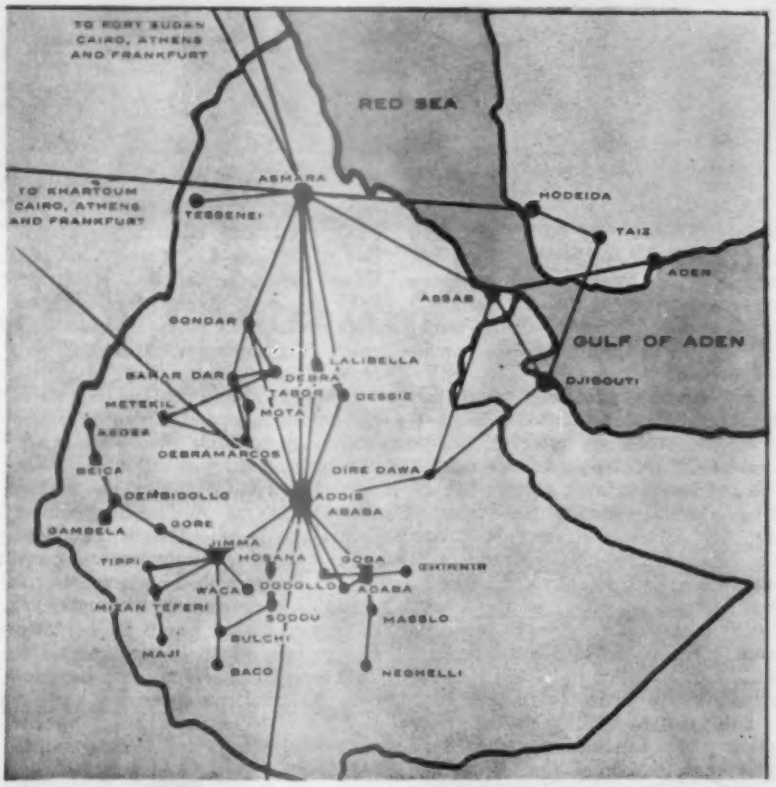
Present trans-African route pattern is only the beginning of the carrier's African projects. Airline already has obtained full rights into Conakry, Guinea. But before extending north from Monrovia, Ethiopian officials want similar rights into Dakar, in the Senegal. These two stops, both north of Monrovia, would then justify staging a flight crew in the area.

At present, the carrier's DC-6B configuration on the trans-African run is 26 first-class passengers and 35 tourist. Normal company DC-6B configuration is 26 and 43. Eight tourist seats are lost in setting up crew bunks. Each weekly flight carries two captains and two first officers. Pilots have about 11 hr. layover in Monrovia before starting back across Africa to Addis.

Ethiopian aviation officials also talk about flight across Africa from Addis to Leopoldville, in the Congo. This route, as well as other projects within Africa, is being held in suspension until the political situation in these areas firms



CARRIER'S trans-African service, Frankfurt and Athens routes are shown above.



DOMESTIC and Middle East route patterns of Ethiopian Airlines are shown above.

ETHIOPIAN Airlines Convair 240 arrives at Addis after flight from Djibouti.

ONE of the carrier's DC-3s unloads sheep at Addis after a domestic flight.

up. Meantime, carrier officials expect to lose $280,000 on the trans-African run during the initial year. By 1963, with increased frequency and jet equipment, it is expected that the route will begin to yield a profit. Some carrier officials think the route may turn profitable sooner.

The carrier's third main route pattern—domestic and Middle East—is gradually becoming more profitable. Out of 23 DC-3 routes, for example, 13 are now operated at a profit. Middle East points now served are restricted although future plans include linking the company's new trans-African route out to Far East points via the Middle East. Company, earlier in its history, briefly operated air service to India. Its present flights to Aden are scheduled to link up with Air India and East African Airways service to the Far East.

Ethiopian, in addition to these three main route patterns, also operates a fleet of six helicopters—one Hiller 12E and five Bells. Started in 1957, the helicopters are contracted out to the government and Point Four clients. Carrier employs four French and one Danish helicopter pilots. It charges $110 per hour average for helicopter work, flew 3,428 hr. in 1959, its peak year. The airline is considering purchase of heavier helicopters.

Ethiopian government, while it wants the carrier to expand as rapidly as possible, also demands that such expansion be achieved without subsidy. The carrier, in fact, is ending its seventh straight year of profitable operation, thanks mainly to its DC-6B operations.

Ethiopian estimates it breaks even on DC-6B flights with 25 passengers. It needs 21 passengers to break even on its Convair flights. On its DC-6B trans-African run, which is not expected to yield a profit for several years, the company figures it can cover cash costs of a flight with 14 passengers. System-wide breakeven payload factor is 36% for 1960.

Last year's revenues of approximately $8,457,060 broke down as follows: Passenger revenues, 64.1%; freight, 18.2%; mail, 3.5%; charter, 9.4%; all other, 4.8%.

Net earnings in 1959, first full year of DC-6B operation to Frankfurt, jumped from $54,196 in 1958 to $296,788. This year, revenues are up 14% while passenger miles have increased 16%.

Carrier's normal annual revenue growth of 12% is expected to decline during 1961. This is because EAL will be running into jet competition while its jets—two Boeing 720Bs—won't be in operation until early 1962. Delivery is scheduled for December, 1961. By the end of 1962, with a full year of jet operation behind them, company officials expect to resume their annual 12% revenue growth.

Decision to buy jet equipment marked a significant step in Ethiopian Airlines' history. Studies had shown that without jets, the company by 1964 would have been forced to abandon most of its international routes. It then would have reverted back to being mainly a domestic carrier.

Thus the decision—thrashed out by company officials at the Imperial Palace level—now permits the carrier to project its future with more certainty. Despite a one year delay in getting government agreement to "go jet," Ethiopian Airlines' officials estimate that by 1965 the

Role During Revolt

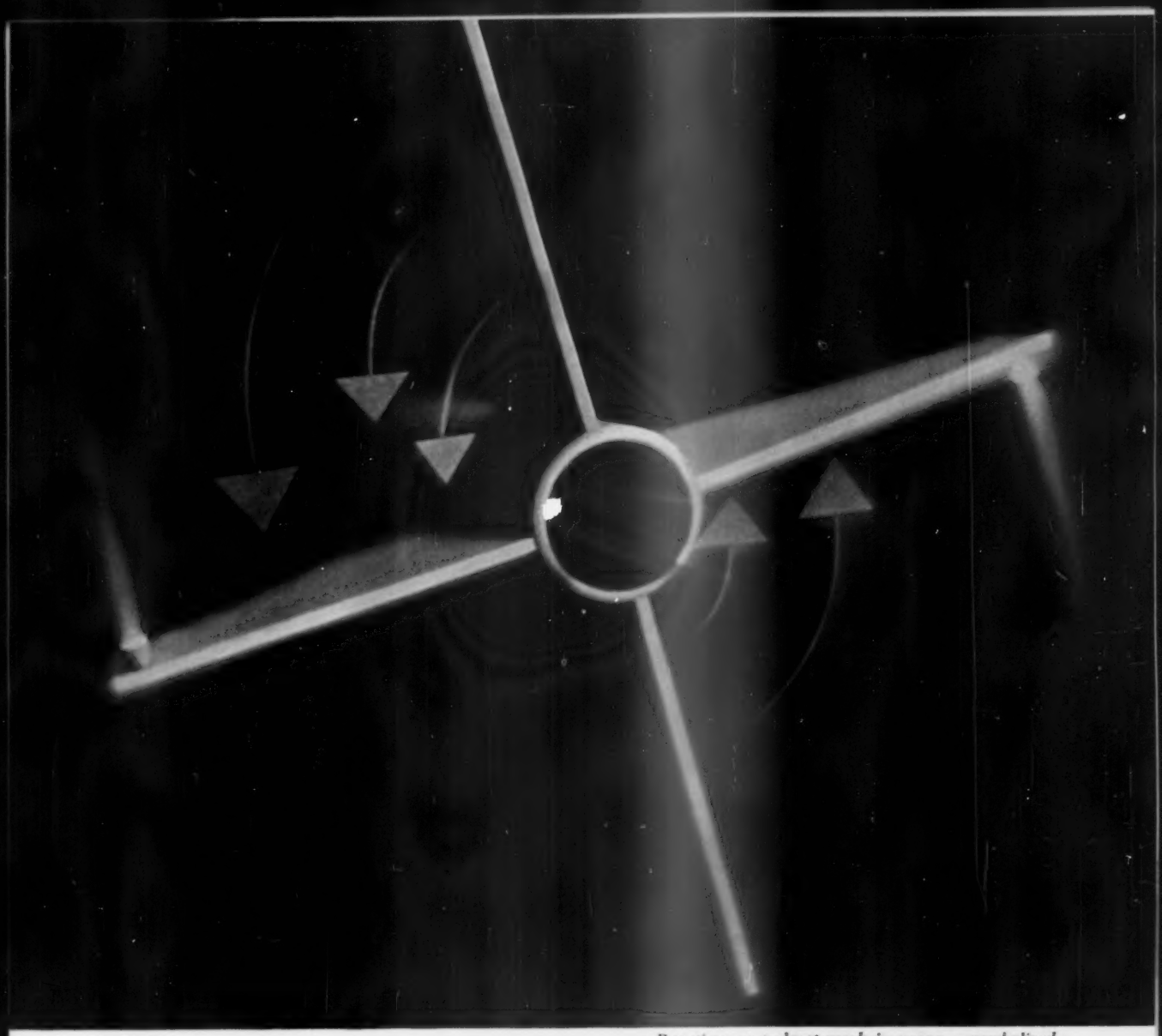
Addis Ababa, Ethiopia—Ethiopian Airlines' facilities and personnel suffered little damage despite severe fighting during the abortive coup d'etat against the rule of Emperor Haile Selassie.

The carrier, managed by Trans World Airlines, resumed complete international service on Dec. 19, even before street fighting in the capital had ended. Resumption of domestic service, on a limited scale, also was well under way.

The company lost only one employe, a German helicopter mechanic, who was shot in Addis while attempting to seek refuge at the Dutch embassy.

The carrier played an important role in the emperor's swift reaction to the revolt, led by a clique of army officers. At the time of the revolt, the emperor was visiting in Brazil. From Sao Paulo his Ethiopian Airlines DC-6B, piloted by company captains Robert Green and Robert Moon, flew the emperor back to Ethiopia within 48 hr.

Main communication out of Addis during initial fighting was achieved by company employes transmitting on equipment in another company DC-6B grounded at the airport. Transmission of news was carried out despite fighting in and around the airport terminal.



Reaction controls at work in space — symbolized.

STEERING GEAR FOR ASTRONAUTS

Conventional aircraft control surfaces will not guide space ships and capsules. Rudders, ailerons and elevators find no resistance and hence produce no reaction to their movements where there is no atmosphere. Even at altitudes only half way up, they are sluggishly ineffective.

The accepted answer to a dependable steering mechanism for astronauts is a system of jet reaction controls developed and produced by Bell Aerosystems Company. First used on Bell's own supersonic X-1B several years ago, the system has been greatly improved and adopted for the X-15, the Mercury man-in-space project and other space vehicles.

Through strategically located, low and high thrust (1 to 1500 pound) rocket engines, Bell's reaction controls not only position and guide the ship by controlling the roll, pitch and yaw, but they also provide for orbit changes and retro-thrust. Some of the jets are throttleable while others can be operated in combination to provide the astronaut positive and flexible control.

This revolutionary steering gear for space, available using monopropellants or high energy bipropellants, is just one of many advanced projects which are currently engaging the diversified talents of Bell Aerosystems Company in the fields of rocketry, avionics and space techniques. Engineers and scientists seeking challenging, long-range career opportunities can find them at Bell.

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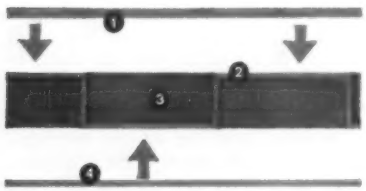
Johns-Manville Announces... MIN-KLAD INTERLOK

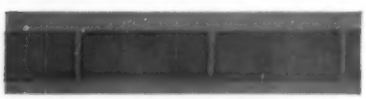
. . . a new structural system interlocking Min-K insulation and high-temperature reinforced plastic

Missile experience shows that in certain heat control situations no one material will perform as well as two (or more)—*an insulation with protective high-temperature facings.*

Problem is how to effectively combine these materials into a structurally strong unit? The answer is Min-Klad Interlok —a new structural system that interlocks Min-K insulation and reinforced plastic, metal or other high-temperature facings.



1) Outer facing, 2) Interlocking web, 3) Core, any one of several Min-K formulations, and 4) Inner facing.



All the above components combine to provide a custom-made structural strong insulating system.

The result: one product that gives the missile designer every advantage of high-temperature plastic or metal foil—strength, toughness, rigidity! Erosion resistance! High heat capacity!

. . . plus the outstanding advantages of Min-K insulation—an insulating core that has the lowest thermal conductivity available for service temperatures up to 2000°F steady-state, and higher for transients. Min-K's thermal conductivity is actually lower than the molecular conductivity of still air.

Wide range of facings

For the hot face, the missile designer can specify Min-Klad Interlok in a wide variety of heat-resistant and/or ablating materials—asbestos-phenolic (ARP-40), and similar reinforced plastics, as well as stainless steel and other heat-resistant metal foils and meshes. For some requirements, the cool face can be made of a different material—for example, one that offers characteristics required for bonding or fastening to other surfaces and parts.

Like all J-M Aviation insulations, Min-Klad Interlok is factory-fabricated to your specifications into external skin panels, heat shields, cylindrical liners or component housings of any shape or size. Write today for technical specifications. Address Johns-Manville, Box 14, New York 16, New York. In Canada, Port Credit, Ontario.

JOHNS-MANVILLE JM PRODUCTS

airline will be reporting annual revenues of $14 million and net earnings of $1.72 million.

It is likely Ethiopian also will order a third Boeing 720B, even before it takes delivery on its first two Boeings next December. Aircraft, powered by four Pratt & Whitney JT3D-1 turbojets each developing 17,000-lb. thrust, is well-suited for the company's 8,000-ft. operation at Addis Airport. Carrier officials say their special altitude and temperature problem at Addis could not be handled by anything but a turbofan-powered aircraft. Aircraft financing, as in the case of the DC-6Bs, is being handled through Export-Import Bank advances.

Ethiopian Airlines currently does complete airframe and engine maintenance work at Addis, both for fixed-wing aircraft and for the carrier's helicopter fleet. Radio and radar upkeep, and 80% of instrument maintenance work, are done as well. Maintenance force totals 255 employes of whom 15 are American and 33 are Europeans from 12 different countries. Productivity is relatively low due to the necessity of training Ethiopian personnel.

Maintenance Problems

Company has had only two premature engine removals out of 35 major overhaul jobs on its P&W R-2800 engines. Company's fleet of three DC-6Bs, two Convairs and seven DC-3 type aircraft fly some 340 scheduled flight hours weekly of which 252 hr. are on international runs. P. C. Simpson, the carrier's maintenance chief, claims special altitude and temperature conditions at Addis Airport have presented no knotty maintenance problems.

Domestic DC-3 operation, however, does. These aircraft are regularly operated in and out of rough strips, some laid out at 9,000 ft. altitude, others in tropical valleys. All the carrier's DC-3s are equipped with single disk brakes and fixed cowl flaps. Gears and stabilizers, which bear the brunt of daily landings on roughly prepared strips, have to be changed after 3,000 hr.

Company's present maintenance set-up will not be altered with the arrival of jets. Carrier intends to continue handling its own maintenance requirements. Boeing has agreed to set up a training operation at Addis and to maintain two technical representatives on the spot for three years. Pratt & Whitney will station two field men, keeping one at Addis on a permanent basis.

Ethiopian Airlines was organized in 1945 when Emperor Haile Selassie requested Washington's aid in establishing a national airline. Ethiopian government wanted American help despite the fact that the British had liberated the country early in World War II and were on the spot. Ethiopian officials

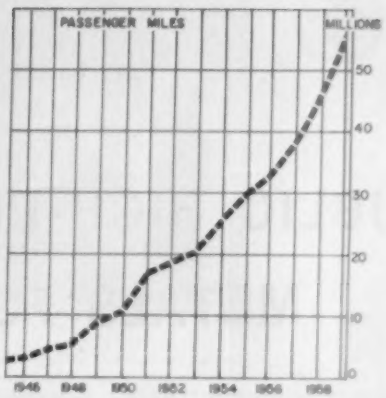


CHART shows Ethiopian Airlines' steady increase in passenger miles since 1946.

traditionally follow a policy of never letting any one country obtain too much influence. Moreover, in 1945 the government was disputing border issues with the British over Somaliland.

U. S. State Department turned over the Ethiopian request to Trans World Airlines, the only U. S. carrier licensed to fly in the region. Management contract between the Ethiopian government and TWA was signed in 1945. TWA was paid an annual management fee of $25,000 for its services. U. S. C-47 surplus aircraft, flown by Air Transport Command pilots especially discharged for the job, provided the raw material for Ethiopian initial operation.

Original contract ran for seven years, until 1952. At that time neither side seemed certain it wanted to continue the relationship. Heavy losses were run until 1949-50, when the line showed a profit, then again began losing money. Several other foreign carriers sought the contract. According to one published report, "British interests" offered not only to operate Ethiopian Airlines but to pay the government for the right to do so.

After a year of indecision on both sides, a new three-year contract was signed in 1953. TWA's right to appoint half the line's board of directors was cut to a single appointment. From 1953 the company began to turn a profit and in 1955 the carrier's present and highly successful managing director, Victor H. Harrell, Jr., took over.

Contract was easily renewed in 1955, one year ahead of time, and presently remains indefinitely in force. TWA management fee currently is $35,000 annually. Harrell, after a long and successful career with Ethiopian Airlines, finally is being recalled by TWA.

Harrell is responsible both to Ethiopian Airlines' board and to TWA management in New York. TWA's management aid to the African carrier won special tribute in a detailed study made of Ethiopian Airlines' operation by the National Planning Assn. in 1959.

Ethiopian officials appear to be satisfied with TWA's efforts at Addis. Link between the two companies helps Ethiopian Airlines in several ways. TWA, for example, charges Ethiopian Airlines only 5% to cover costs of TWA purchases for the African carrier. If bought straight from Addis, this fee would range from 10 to 15%.

TWA, under separate contract, also operates a National Airlines Training Program at Addis with funds supplied by ICA. The U. S. carrier also helps Ethiopian with special problems, such as studies leading to jet equipment purchases, without charging a service fee.

On traffic, TWA gets about the same amount of business from Ethiopian as it gives the carrier. TWA people on loan to Ethiopian Airlines, however, are under strict orders to put the airline's interests first. Ethiopian officials say they have no complaint on this score.

Ethiopian's main complaint deals with slow advancement of Ethiopians in the company. Highest operating post held by an Ethiopian is director of accounting. All other top posts, as provided for under the present contract, are held by TWA personnel on loan to the carrier. Harrell feels Ethiopians are well enough trained to operate the line if it were just a regional carrier. But with the line's routes now expanding rapidly, and jet equipment coming in, it's hard to see how the current rate of advancement can even be maintained.

Personnel Problems

If the advancement is slow, there are some good reasons. The country, for example, still has an illiteracy rate of well over 90%. This naturally makes recruiting of basic personnel difficult. Well-educated Ethiopians usually are snapped up by the government, or refuse to enter the airline unless a high post is offered them.

Finally, supply of flight and ground crew material currently is being squeezed off. Ethiopian air force is expanding and wants to hold on to its trained personnel.

Yet, of the carrier's 40 fixed-wing pilots only 19 are Americans—many of them having flown with the airline for 10 years—while the rest are Ethiopian. Six Ethiopian pilots are DC-3 captains and one captains a Convair. Latter pilot will be checked out on DC-6B equipment in 1961.

The carrier presently has four Ethiopian girls working as hostesses. Ethiopian families, however, usually do not regard a hostess post as a fitting job for their daughters. Carrier is trying to offset this by filming girls soaking up culture in Athens and other Ethiopian Airlines' layover points in Europe and Africa.

REPUBLIC HIGH-PERFORMANCE METALS FOR THE HU2K

Scheduled for fleet delivery in 1961, the all-weather Kaman HU2K "SEASPRITE" was developed to meet *high-performance* requirements of the U. S. Navy. Working closely with Kaman design engineers, Republic Steel is supplying light gage titanium and stainless steel for the HU2K.

Selected for its resistance to corrosion and abrasion, stainless is used in leading edges of the rotor blades. The titanium—Type RS140—is used in 1½″ x 18″ strips. Assembled in bundles of 88, these strips are machined into retention straps that are a vital component in the rotor system.

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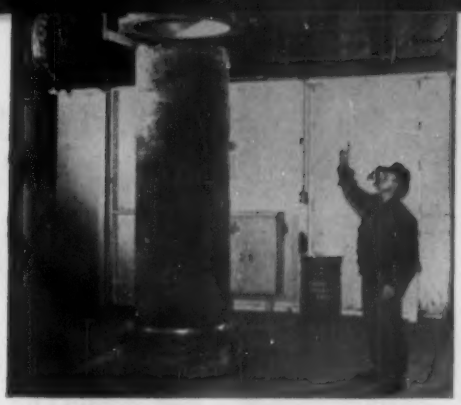

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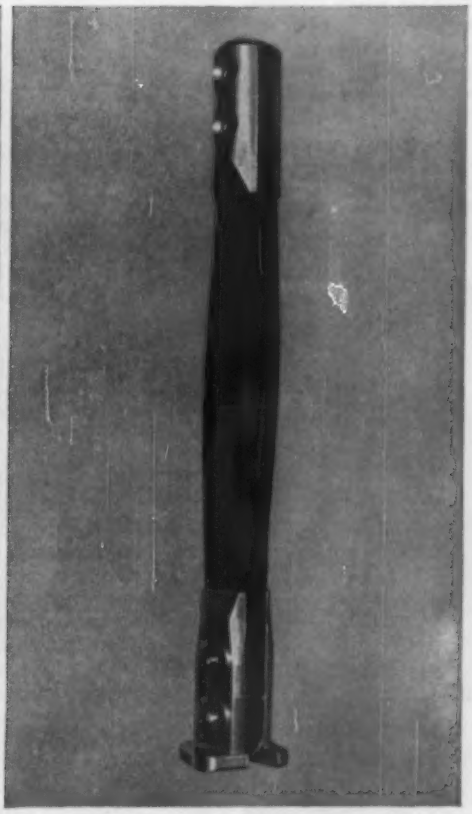

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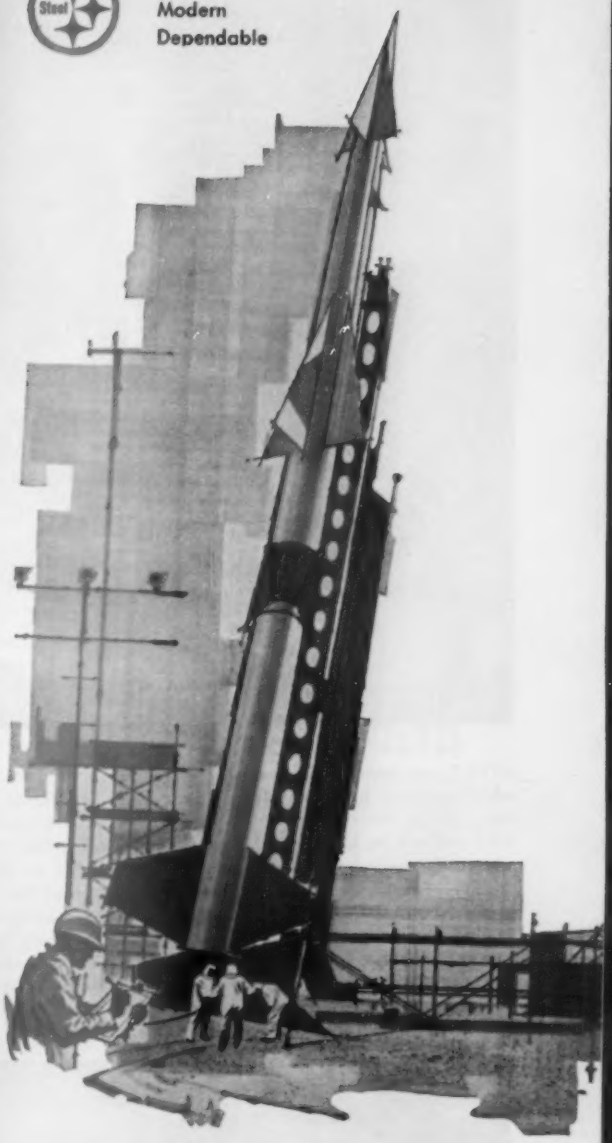

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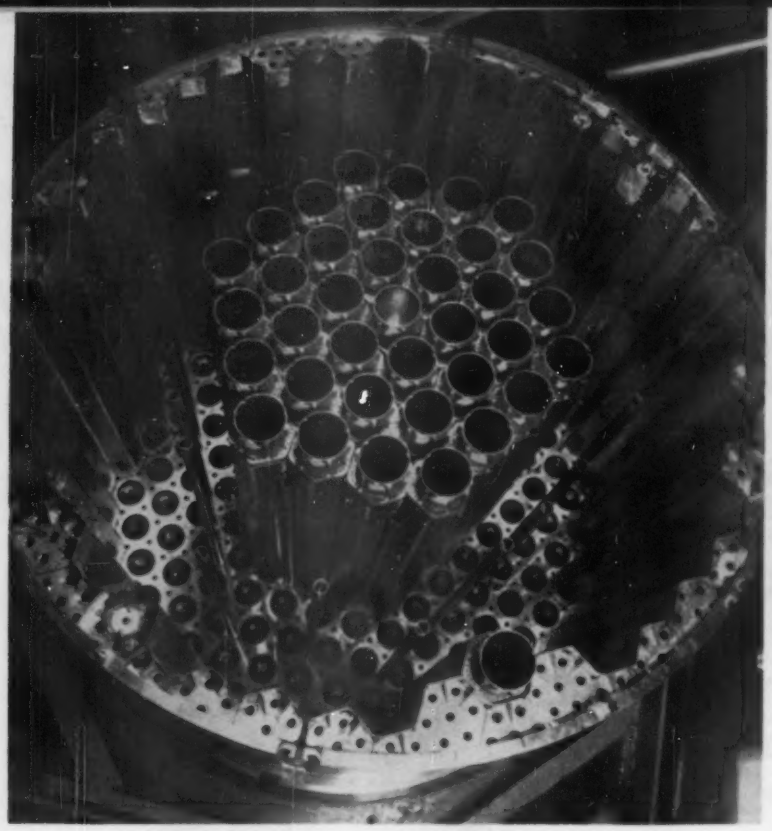
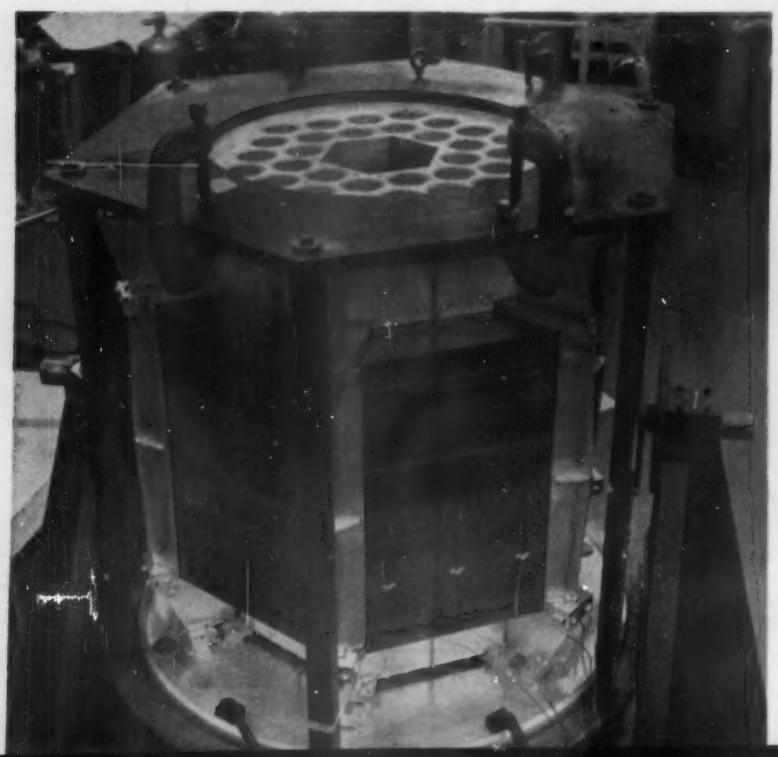
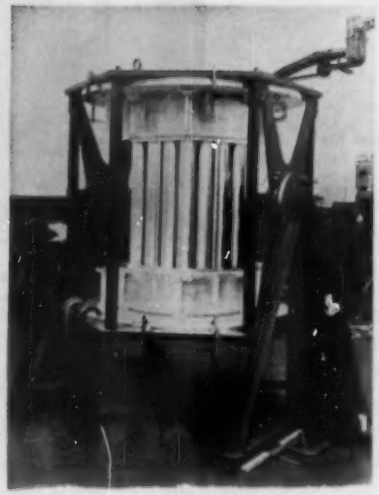


HTRE-3 core shown during assembly above consists of many hexagonally shaped zirconium oxide moderator bars which have a large round hole along their centerline. Small fuel tubes will be fitted in the center of these holes. The engine air will pass through the holes and will be heated by the fuel tubes. Small tubes standing alone throughout the core are for control rods. Reflector blocks of beryllium are placed around the perimeter of the core. Reactor for Heat Transfer Reactor Experiment No. 2 (HTRE-2) is shown above. It closely resembles the HTRE-1 reactor except that a hexagonal section has been removed from the center of the core. It is possible to test a wide variety of experimental reactor segments in the center of the HTRE-2 unit. The experimental segments are too small to "go critical" and produce power if tested outside of the HTRE-2 reactor. The first ceramic fuel elements were tested in this reactor.





ALUMINUM fuel element tubes for the HTRE-1 reactor are in place above during an intermediate assembly stage.

Special Report:

Direct-Indirect

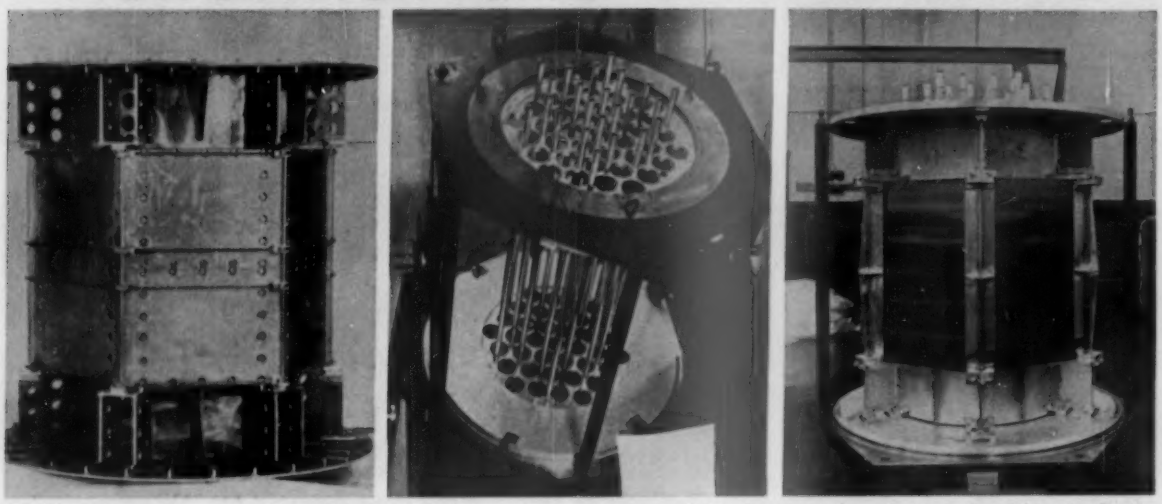
This is the second of a series of articles on the various applications of nuclear power to aircraft and space vehicles.

Washington—An intense competition between the indirect and direct cycle nuclear turbojet engines has been in progress since the Aircraft Nuclear Propulsion program was initiated in 1950, and it is still impossible to show that either engine type is clearly superior to the other.

Today, most experts apparently regard the General Electric direct engine as the best nuclear powerplant for the near future and they credit the Pratt & Whitney indirect cycle engine with more long term growth potential. They also emphasize that this evaluation is tentative and that a realistic technical decision cannot be made for at least two years—until more test data is available.

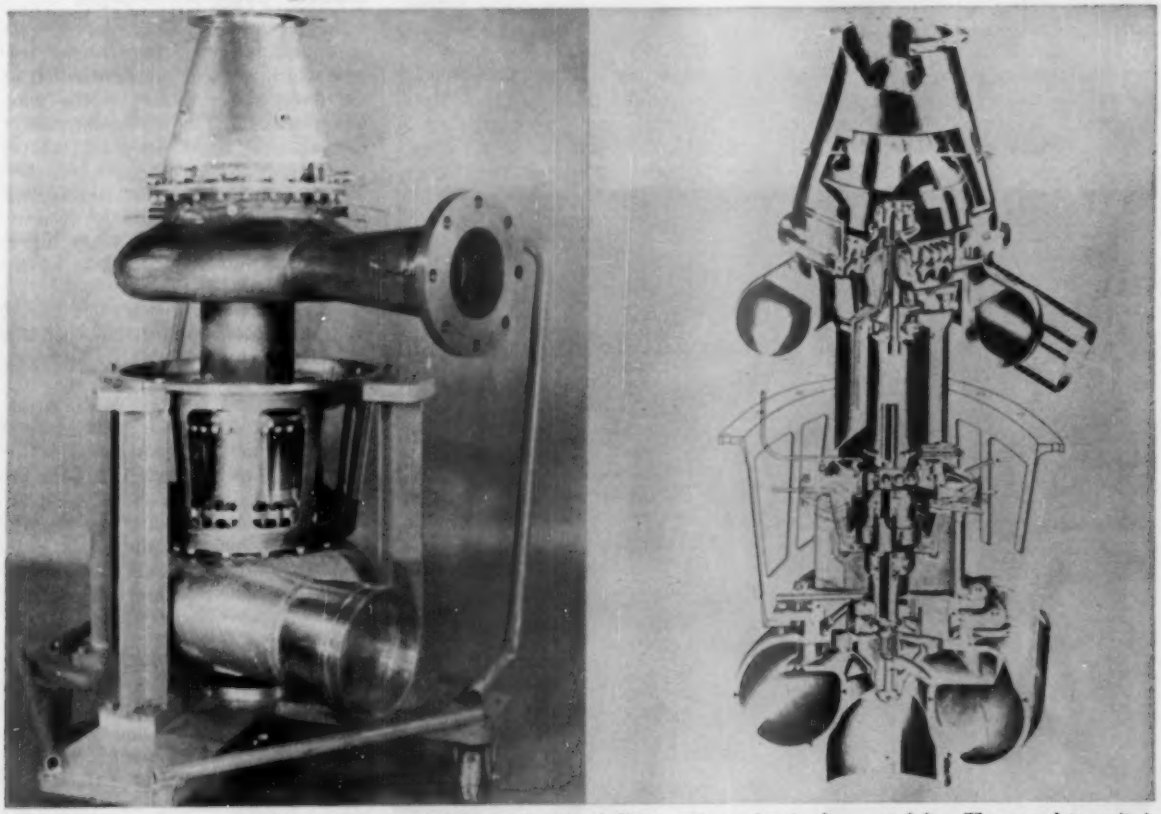
The details of the nuclear powerplant competition are extremely complex but a general comparison can begin with two points on which proponents of each engine agree. These are:

- **Principal development** problem with the direct cycle engine is the reactor. This engine requires an extremely advanced reactor by present standards, and in many ways it pushes nuclear technology beyond its current limits.
- **Indirect cycle engine** has a more conventional reactor, and its primary development problems are in the heat transfer systems needed to get the

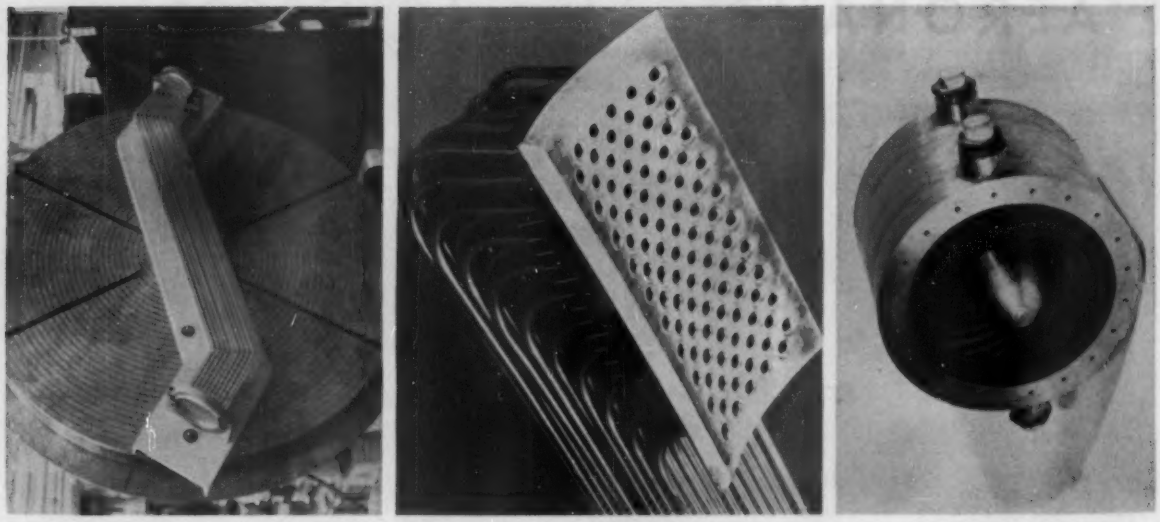


MECHANICAL mockup of the General Electric HTRE-1 reactor core is shown at left. Center cut shows first experimental reactor for the direct air cycle nuclear engine program in early stages of assembly. Unit was used for HTRE-1 test. Core of the HTRE-1 reactor is almost completely assembled at right. Heavy beryllium plates have been secured around the fuel element tubes.

Nuclear Engine Choice Awaits Test Data



LIQUID metal turbopump developed by Pratt & Whitney for the indirect cycle engine is shown at left. The complete unit is approximately 4 ft. long. Pump section for the liquid metal is in the lower portion of the picture and the upper section is the turbine driven by engine bleed air. Cutaway drawing of the liquid metal turbopump shows the centrifugal pump for the liquid metal at the lower end and the engine air driven turbine at the upper end.

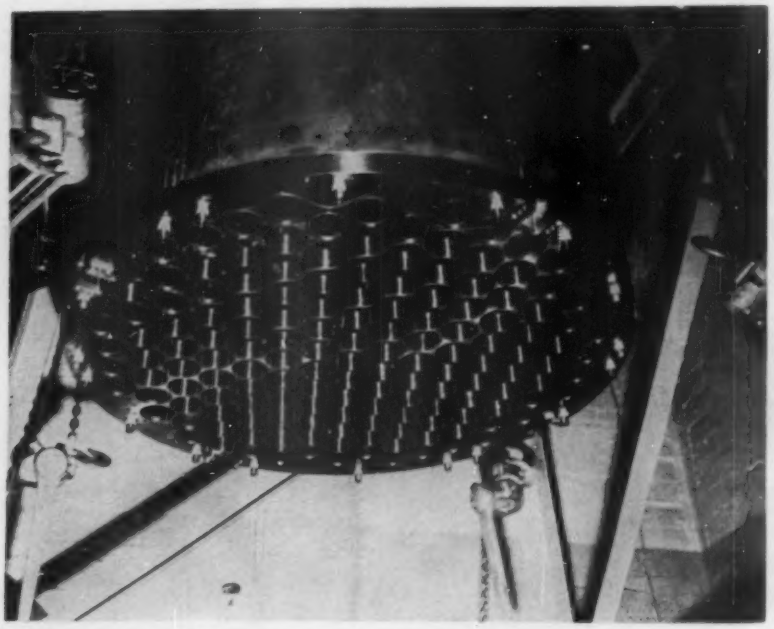


TYPICAL intermediate heat exchanger design under consideration for the indirect cycle engine is shown at left. The intermediate heat exchanger is needed on the two loop system to connect the primary and secondary liquid metal circuits. Reliability problems with the heat transfer system of the indirect cycle nuclear engine are illustrated to a degree in this 100 tube header section for the radiator that heats the engine air (center). Experimental radiator core for an indirect cycle nuclear engine is shown at right before a test at Pratt & Whitney. Specific designation for this design is the tube-and-spiral-fin-involute type.

nuclear heat from the reactor to the engine air stream.

This does not imply that the indirect cycle reactor does not have very high performance compared with current nuclear power systems. Any reactor useful in an aircraft will have to exhibit such performance. The indirect cycle reactor has a much higher operating temperature and a much higher power density than operational reactors on ships and in stationary power units on land. Although it represents a major advance in reactor technology, its lineage stems more from current work, and it is more an extension of conventional concepts than the direct cycle reactor.

Consequently, the indirect cycle reactor has great appeal to nuclear scientists and engineers. Its development is not near completion, but most of these experts regard it as well within the state of the art demonstrated by research work in the past few years.



AFT END of the HTRE-3 reactor is shown above when the reactor was in its vertical assembly jig. Hot air from the reactor flows through these holes and into the turbines on the modified J47 jet engines used by General Electric in their HTRE-3 tests.

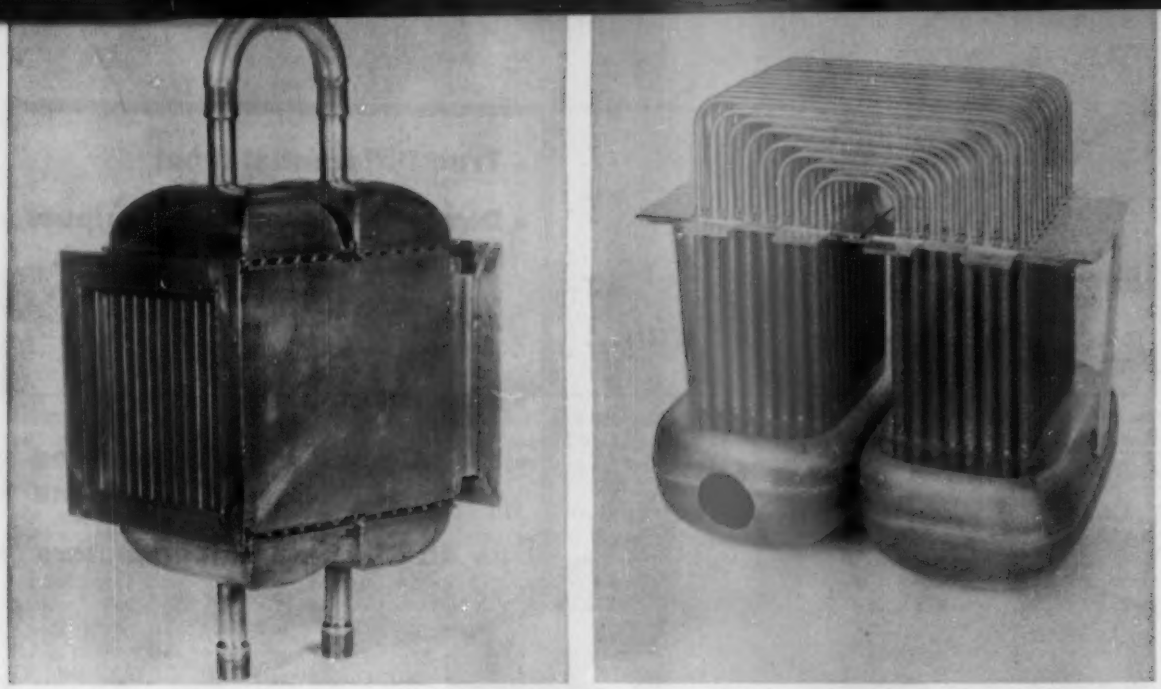
Indirect Cycle Advantages

Specific advantages of the indirect cycle unit include a total reactor volume which is about one-fourth that of the direct cycle reactor for the same power output. The maximum reactor dimension is about one-third that of the direct cycle reactor—roughly two feet compared with six feet in diameter. Power density of the indirect cycle reactor can be about six times higher than the direct cycle according to current estimates.

Shielding weight, which is a critical item in the design of a nuclear-powered aircraft, is extremely sensitive to reactor volume and diameter. Shield weight is approximately a function of the square of the reactor diameter. Therefore, if power output stays constant, a moderate increase in the reactor diameter will cause a major increase in shield weight. The small reactor volume and the relatively low shield weight is the main reason why many nuclear engineers believe that the indirect cycle will prove the lightest possible configuration.

Small Volume

Small volume of the indirect cycle reactor is possible because it uses a highly efficient liquid metal heat transfer agent and reactor coolant. The nuclear engineer tends to regard the liquid metal as a coolant for the reactor, and the aircraft gas turbine engineer looks on it more as a means of delivering heat energy to the propulsion system. At any rate, the heat transfer system



FLATTENED-fin-and-tube radiators have also been tested in the Pratt & Whitney radiator test program. This is one of the better designs as far as heat transfer performance is concerned. Ease of manufacture is one of the most important points in the selection of a radiator design. Fins on the straight-tube-and-fin design at right are tight spirals with complete fin for each tube cut from same piece of metal.

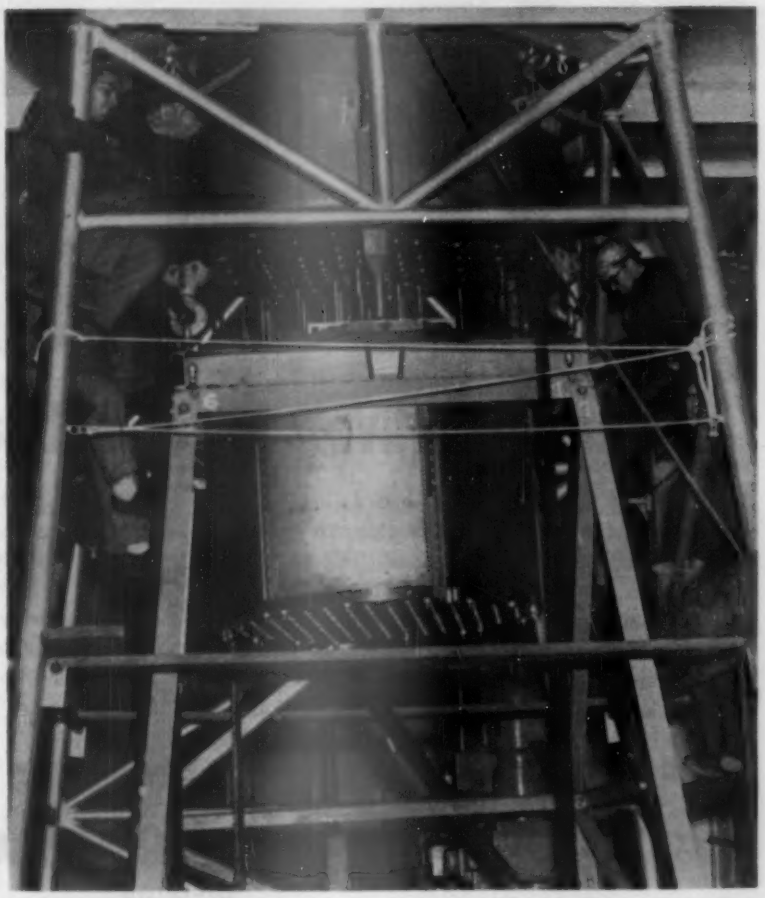
must be designed to deliver large quantities of heat to the turbojets under rapidly varying conditions, and at the same time, the reactor temperature must be kept from exceeding the maximum allowable level.

Compared with the indirect cycle's liquid metal heat transfer agent, the direct cycle must use air for this purpose, and air is not very efficient. The heat transfer properties of a coolant are basically a function of its thermal conductivity, its specific heat or heat capacity and its density, and the relative attractiveness of liquid metal and air can be illustrated to a considerable extent by comparing these factors.

Heat Transfer Comparison

Direct comparisons are rather difficult because these three properties are somewhat temperature and pressure dependent. Under the operating conditions of interest, however, most liquid metals will have a density 1,000 to 1,500 times higher than air. The specific heats of air and the liquid metals are roughly the same. Pure solid metals have the highest thermal conductivity, followed by metal alloys, non-metallic solids, liquids and gases in that order. In general, the thermal conductivity of gases is about one-tenth that of liquids.

Over-all then, the heat transfer efficiency of a given volume of liquid metal is several thousand times higher than that of the same volume of air. Only reason that the direct cycle, air-cooled reactor size can approach the size of the indirect cycle reactor is because a very



FULLY assembled HTRE-3 reactor is mated with the heavy shielding plug which is secured in front of the reactor to keep radiation from streaming out of the core.

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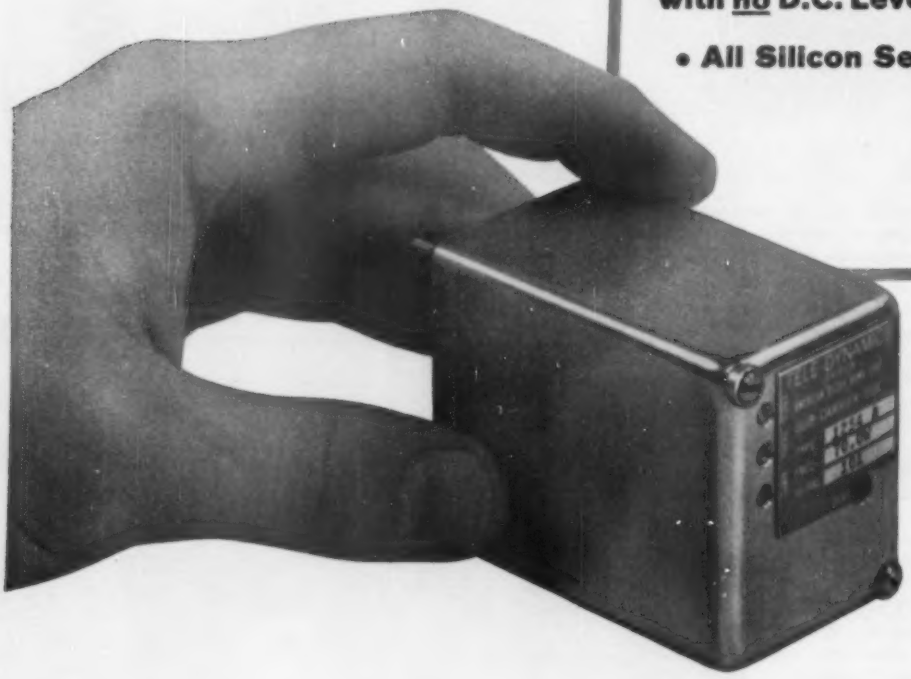

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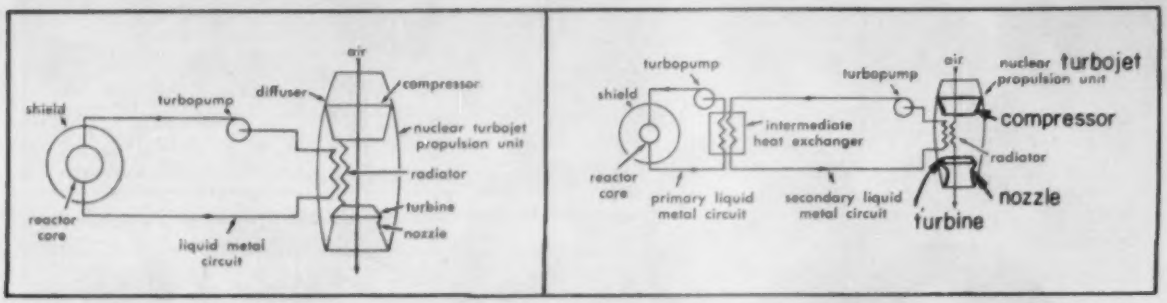

CURRENT Pratt & Whitney indirect cycle nuclear powerplant is a two loop system shown in the right schematic drawing above. Ultimate objective of indirect cycle designers is the much lighter and less complex single loop system shown in the left drawing. Improvements in radiator materials and liquid metal heat transfer fluids must be made before the single loop becomes possible.

large volume of air is moved through it by the rotating machinery of the gas turbine engine. Direct cycle nuclear turbojets will have air flows in the neighborhood of 300 lb. per second, or around 4,000 cu. ft. of air a second. This is roughly twice the air flow of the J79 turbojet.

There are two main drawbacks to the use of liquid metals as heat transfer agents—in most instances they are highly corrosive and pyrophoric.

The indirect cycle engine has another major design advantage due to better heat transfer conditions. The radiator used in this engine to heat the engine air does not have to be shielded, and it can be designed to give the maximum heat transfer efficiency. Diameter of this radiator can be taken up to 9 ft. or so, and the engine air can be slowed down so its pressure losses during the heat transfer are reduced.

As the pressure losses are reduced, it is possible to operate at a lower-radiator-temperature and still produce the same thrust.

It is not feasible to increase the diameter of the reactor in the direct cycle engine simply to get better heat transfer performance. The requirement for the lowest possible reactor diameter to minimize shield weight is the most stringent facing the direct cycle designer.

If reactor diameter were increased while power output stayed constant, the increase in shield weight would quickly offset any improvement in heat transfer efficiency, and the engine's power-to-weight ratio would be reduced so its effectiveness in an aircraft would be lowered.

Design of the radiator for the indirect cycle engine is not a simple matter, and its diameter and length will vary depending upon the performance desired from the aircraft. Radiator size is a function of several variables, including thrust desired, operational altitude, exit temperature, pressure drop, radiator weight and maximum frontal area, which is limited by the maximum fuselage diameter, which is in turn fixed by the flight speed.

In general, if very high thrust and high flight speeds are required, the radiator will be lengthened to provide a high exit temperature, but this will increase thrust only to the point where the pressure losses which accompany the increased length do not overcome the thrust gain due to the higher exit temperature. The radiator length which does produce the maximum thrust for a given speed and altitude may not be optimum as far as total engine performance is concerned. Adjustments to length and diameter usually have to be made to get the lowest thrust-to-weight ratio for the entire engine.

While the radiator is responsible to a large degree for the flexibility and high performance of the indirect cycle engine, it is also one of the major design problems with that engine. Great strides have been made in radiator and heat transfer fluid research and development during the past 10 years. Many difficult problems have been solved concerning the use of highly corrosive liquid metal heat transfer fluids and a wide variety of radiator materials and their assembly techniques.

Dual Loop System

As a result of this work, it is now considered possible to operate an indirect cycle engine using two heat transfer loops. The primary loop in this system circulates a fluid through the reactor and out into an intermediate heat exchanger. The secondary loop is entirely separate and circulates a different kind of liquid metal through the intermediate heat exchanger and into the radiator which heats the engine air. There is no mixing of the two heat transfer fluids in the intermediate heat exchanger.

The two-loop, indirect cycle engine is the type which will be used in the Convair testbed aircraft if the indirect cycle is selected for flight. This is also the type of indirect cycle engine used in the comparisons made concerning the relative weights, efficiencies, etc., of indirect and direct cycle systems.

Radiators and heat transfer fluids must still be improved further, however, before it is possible to take full advantage of the indirect cycle system by constructing an engine with only one heat transfer loop that runs directly from the reactor to the radiator. Two main problems stand in the way of development of a one-loop powerplant, which would significantly reduce the weight and complexity of the indirect cycle engine. These are to develop:

• **Radiator material** which is resistant both to oxidation from the air passing over the hot tubes and internal corrosion from the liquid metal passing through them. On the current two-loop engine design, the primary loop passing through the reactor is filled with a highly corrosive liquid metal, the exact composition of which is still secret. The solid metal used to contain this liquid metal must be corrosion-resistant at a very high temperature. Columbium is one of the few base metals which has this property, and a columbium alloy is used for the tubing in the primary loop. However, columbium oxidizes rapidly at elevated temperatures.

It has not been possible so far to develop an effective cladding for columbium or an alloying substance which would allow it to be exposed to air at high temperatures. If this can be done, the one-loop system will be possible. On the two-loop design, the primary loop can be enclosed and the oxidation problem eliminated. The secondary loop, which includes the engine radiator, is made of stainless steel which will resist oxidation at the required temperatures. It does not have a strong resistance to corrosion, however, so the liquid metal used in the secondary loop is a non-corrosive sodium-potassium alloy.

• **Heat transfer fluids** which do not become radioactive when they pass through the core of a reactor. The main reason that the sodium-potassium liquid metal alloy cannot be used in the primary loop is that it is highly activated as it passes through a reactor, and any engine radiator which used it as a heat source would have to be heavily shielded. Use of shields around the en-

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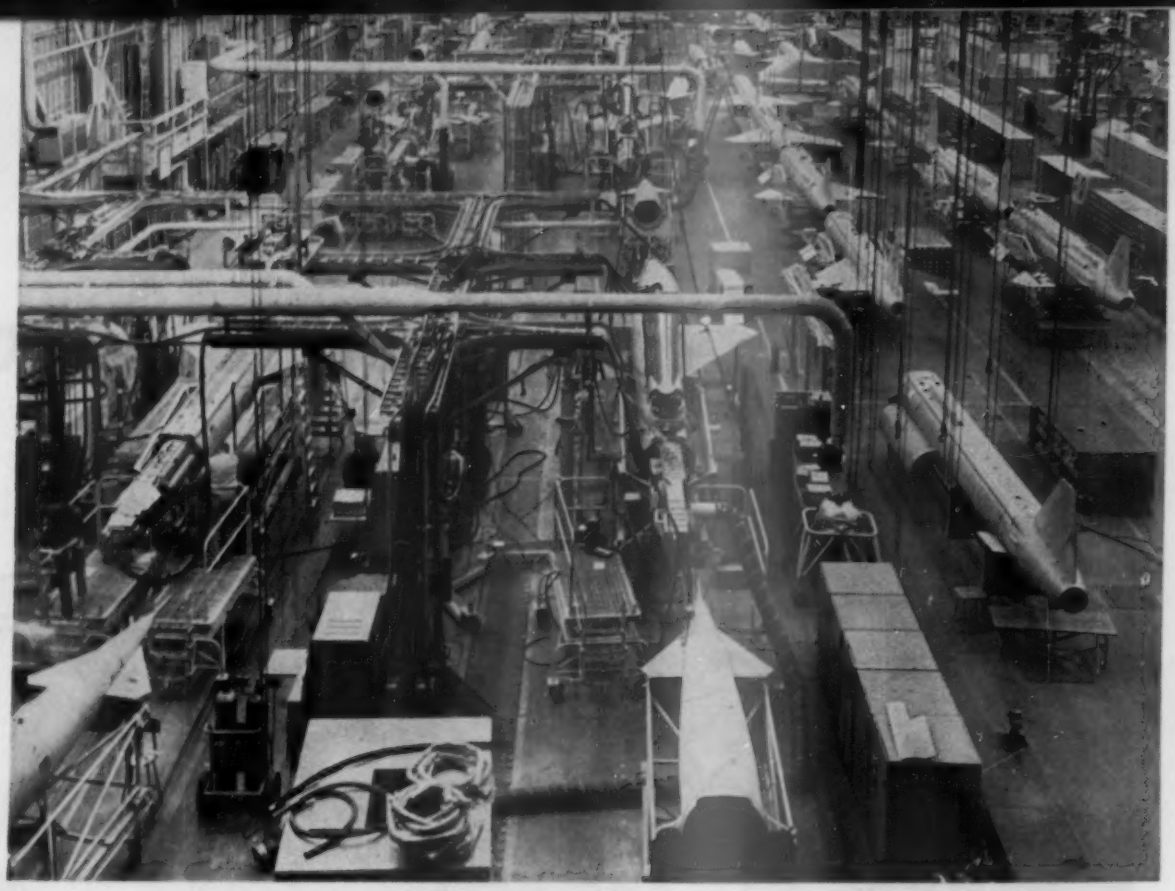


North American's Hound Dog Production Line

North American Aviation's production line for the GAM-77 Hound Dog air-to-surface missile carried by Strategic Air Command Boeing B-52 bombers is shown for the first time. Several hundred of the supersonic missiles were ordered by Air Force for delivery to SAC.

gine radiators would negate the main advantages of the indirect cycle—lightweight and radiator size flexibility.

Two-Loop Complexities

It seems fairly certain that the necessary materials will not be developed in time to make the first generation indirect cycle engine a one-loop system.

Developing an operational two-loop engine will be a major engineering achievement. The four indirect cycle engines needed in the Convair testbed aircraft will have a total of more than 18 mi. of tubing and thousands of connections and joints in their radiators, pumps and intermediate heat exchangers.

The task of keeping these systems from leaking is formidable, and it is still a development problem. If the development is successful and it is possible to build complicated heat exchanger systems of this type which will give thousands of hours of leak-free service, then it will be one of the first times that any completely reliable, high pressure, high temperature, nonleaking fluid power system has ever been constructed. The necessity for leak-free operation is doubly critical on these nuclear engines because the liquid metal heat transfer fluids are pyrophoric. Any time the system leaks, it catches fire.

Substantial engineering efforts have gone into the development of the radiators, pumps, etc., needed for the indirect cycle heat transfer systems. This effort includes fire warning systems and special valving to isolate leaking sections of the system. Most of the work directly related to aircraft engines has been carried on by Pratt & Whitney and the Oak Ridge National Laboratory. A number of other contractors have contributed basic knowledge in this field which is applicable to both flight and ground-based indirect cycle nuclear powerplants.

Radiator Development

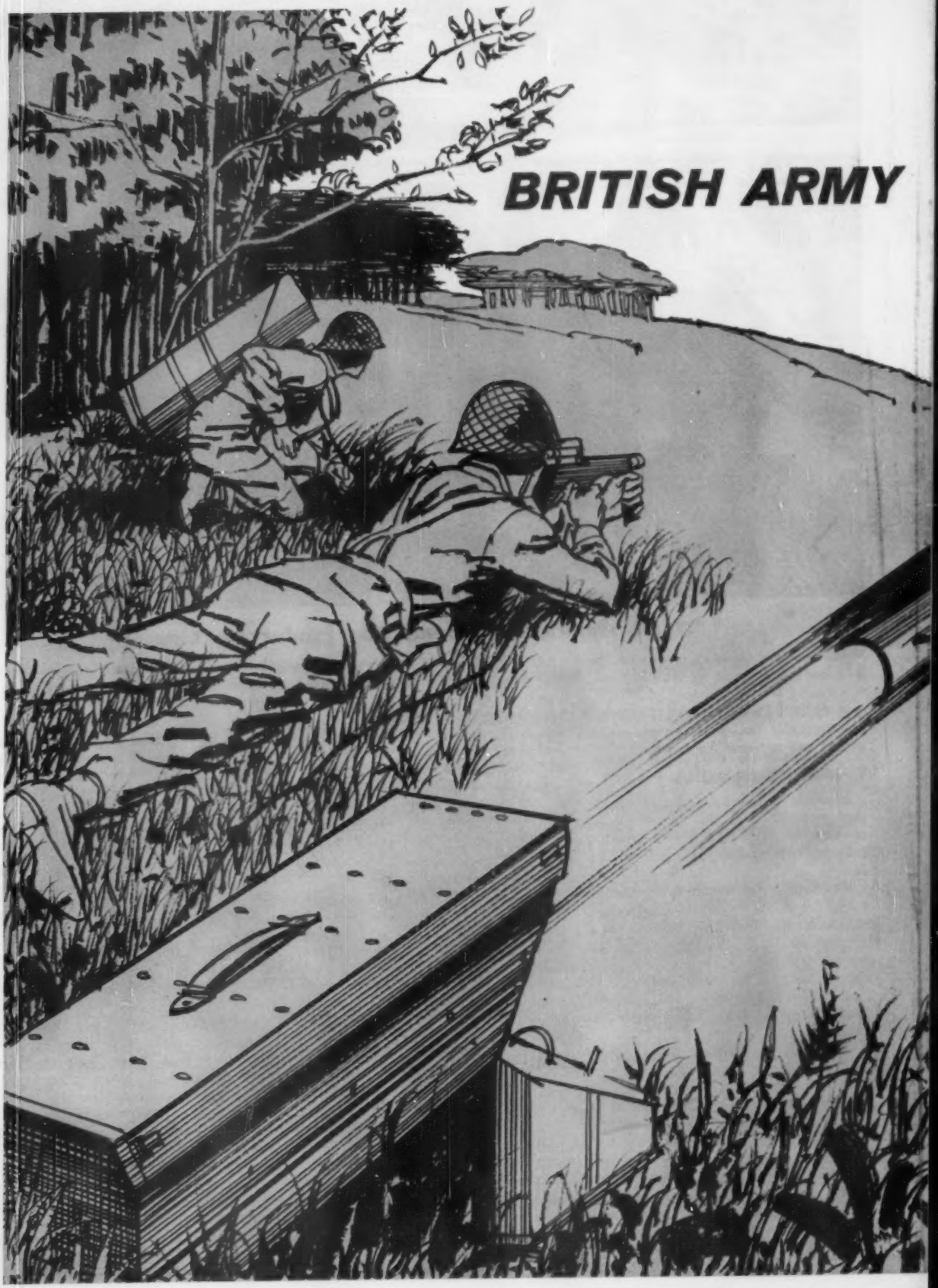
Two main directions have been taken in radiator development, one toward more efficient tube geometries and arrangements, and the other toward longer life and greater dependability. Several years ago, improvement was needed in both directions.

The largest part of Pratt & Whitney's research effort has been directed toward improving efficiency. While many individual tube geometries and tube arrangement patterns have been tried, all of the radiators have had either smooth wall tubes or tubes with fins. One of the most successful radiators built to date is the spiral or involute type shown on page 43, which uses smooth wall tubes. One configuration is considered to be somewhat more attractive than the involute type, but this is now scheduled for use in the first flight type engine and its exact geometry has not been revealed.

Improved Reliability

Reliability improvement has been the principal objective of the radiator work at Oak Ridge, and some units have been run there up to 15,000 hr. without trouble. The main problem has been that it has been nearly impossible to build good radiators consistently or to predict on the basis of inspection records which radiator will give satisfactory performance and which will not.

Most radiator work in the future by all contractors and agencies apparently will be directed toward improving the reliability of the units which past research has shown to be the most efficient. This can be done only through laborious cut-and-try testing to improve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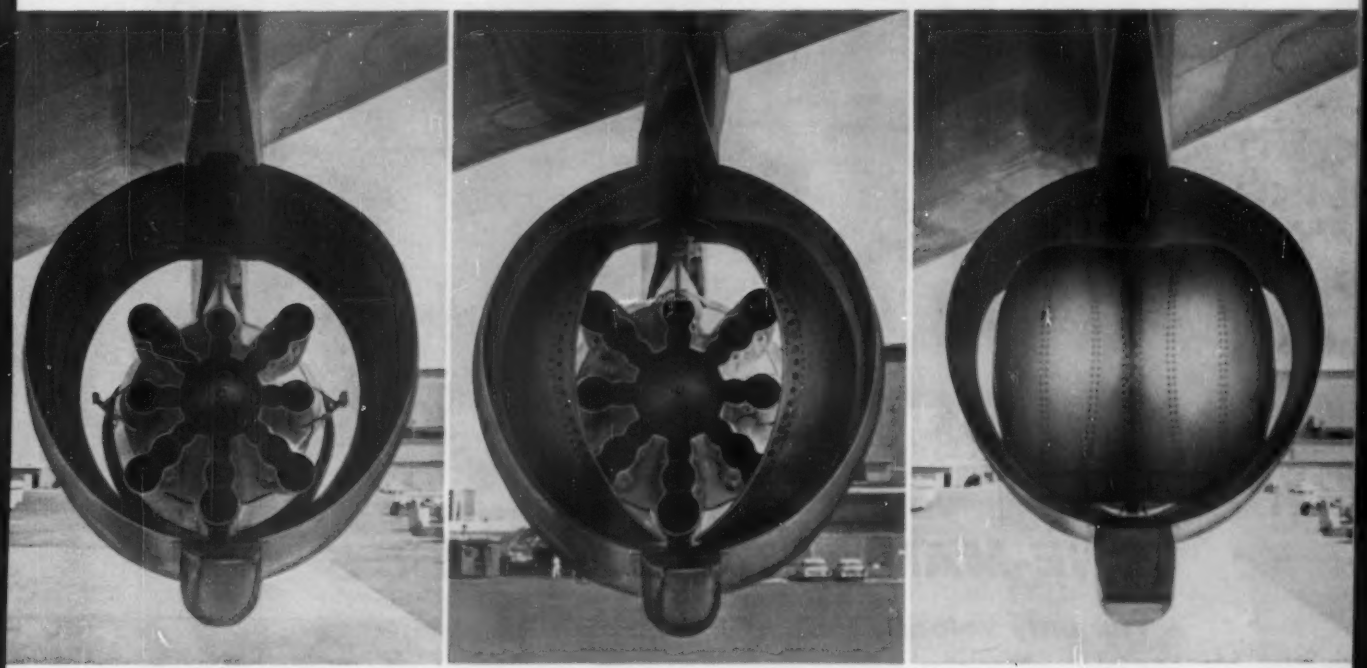

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No other metal makes such a material difference in so many applications.

inspection and fabrication techniques.

In fire detection and control research, tests have shown that small leaks in the heat transfer system and the fire which accompanies them may go undetected for 5-13 min. before they become catastrophic. Tests have also shown that fires may be detected and stopped in less than one minute by properly designed fire warning and control systems. Fire will be controlled by building radiators and other units most likely to leak so that sections can be by-passed and isolated.

Leaks Cause Power Loss

By-passing a section or two in this manner probably will reduce the power which can be developed by an engine. If the leak occurs in a major unit, such as a main heat transfer pump, then the engine will have to be shut down unless the weight penalty of redundant units is accepted. These pumps and other large components of the system have shown themselves reliable in tests.

Fire detection systems will have to be designed specifically for a given engine-airframe installation. Presumably, the sensing elements in the system will have to consist mainly of strategically placed temperature gages on the outside of the engine systems and their supporting structure, and of sensitive pressure gages which will respond to small, unexpected pressure drops in the heat transfer lines.

Centrifugal turbopumps have been developed to circulate the liquid metal through the two heat transfer loops of the indirect cycle engine. These pumps will be driven by bleed air from the turbojet compressor. A pump configuration, shown on p. 41, suitable for use in the Convair test aircraft has been tested successfully at an output of 3,000 gal. per minute. One of the vital design features of this pump is a dynamic seal which throws any liquid metal leakage back into the line. This seal has proven very effective and it is one of the main reasons for the pump's good test record.

Three types of valves are needed in the liquid metal heat transfer system. Control valves are needed to regulate the flow of metal through the reactor. Isolation valves must be provided to shut off the portions of the system which develop leaks, and fill and drain valves are needed to service the engine.

Common problems with all of these valves are the development of units which will not be self-welding or accumulate any deposits on their parts when used in a liquid metal system. Leakage must not occur along any of valve stems, and the isolation valves cannot leak past their seats.

One of the intermediate heat exchangers tested for use on the Convair testbed engine is shown on p. 42. This is a typical unit of this type with direct transfer surfaces and no fins. Main development problems concern the reliability of the header joints at each end of the exchanger and thermal stress reduction.

The liquid metal system also requires some means of allowing for the differential expansion rates of the liquid metal heat transfer fluid and the tubing that contains it so that proper operating pressure will be maintained. This is provided by a unit, similar to an air accumulator in a conventional hydraulic system, which has a flexible metal surface. Helium gas is used on one side of this surface to maintain pressure against the liquid metal flowing along the opposite side.

First turbojet engine planned for use with the indirect cycle system was the Pratt & Whitney J91. This extremely large engine has a compressor inlet diameter of almost 6 ft. Its development was terminated in 1957 when the WS-125A attack aircraft was abandoned. The complete J91 had been run by the time the cancellation came, and its components were in an advanced state of development.

Current indirect cycle system will power four modified Pratt & Whitney J58 turbojets if it is used in the Convair testbed. Diameter of the radiators for these powerplants will be about 2 ft. greater than the rest of the engine. The J58 compressor section will have to be lengthened to provide a greater compression ratio, both to compensate for the losses in the radiator and the turbine wheel and to provide drive air for the heat transfer pumps. The turbine section will have to be modified to provide more power for the compressor.

The modified J58 will be tested extensively on hydrocarbon fuel before it is mated to the nuclear heat source, which is scheduled for 1964.

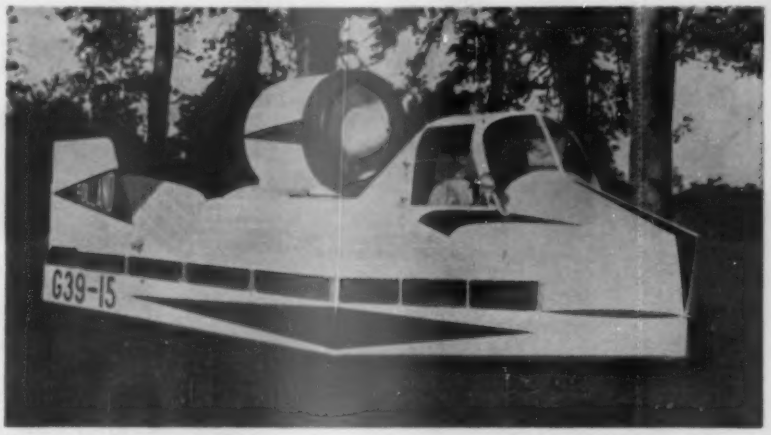
At least two reactors will be used with the four modified J58s in the Convair testbed. It is possible that three or four will be used to increase reliability. Interconnected heat transfer systems would be used so that all four turbojets could still be operated in the event that any of the reactors had to be shut down.

Complete flight-weight direct cycle engine, the X-211, is scheduled to run for the first time on nuclear power in a couple of years. Development of the reactor for this engine has advanced through three major test programs, and its configuration for use in the Convair testbed is now being set.

Direct Cycle Problems

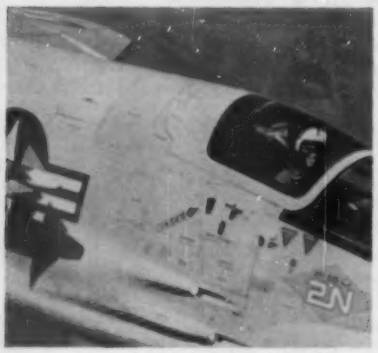
Rotating components for the X-211 engine are a more difficult design problem than those on an indirect cycle engine because they are subjected to the full intensity of the reactor's radiation, while the indirect cycle engine is relatively shielded. The drive shaft on the X-211, which connects turbine and compressor, passes through the reactor core. Strength and durability of these parts is not the primary concern—it is residual radiation emitted by the engine parts after long periods of operation that causes trouble. Some alloying elements in turbojet construction materials remain highly radioactive for long periods after the engine is stopped, making even minor engine servicing a major operation.

Cobalt is one of the alloying elements which emits residual radiation for a long time. Hot parts of jet engines, such as the nozzle diaphragms, normally



Hawker Siddeley Tests Ground-Effect Vehicle

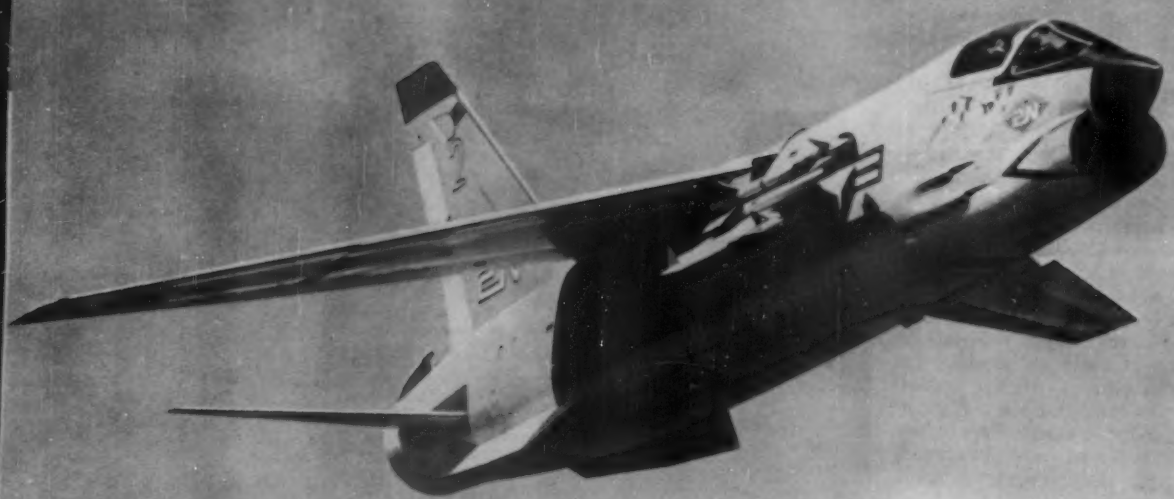
Hawker Siddeley Group is testing its first ground-effect vehicle at the Folland Aircraft factory at Hamble, Hampshire, England (AW Aug. 29, p. 95). Concept is similar to the Cockerill-Saunders Roe Hovercraft. Annular jet of high-velocity air is directed downward and inward all around the vehicle edge, trapping an air cushion beneath the vehicle. Separate engines are used for lift and propulsion.



Footnotes to the Crusader's 203,512th flight

This was a test flight for a new *Crusader* — the all-weather F8U-2N pictured here. It was a busy day for *Crusaders* all over the world. Over 700 of these carrier-based fighters have joined Navy and Marine squadrons since the first *Crusader* won the Thompson and Collier trophies. With the more powerful engine and armament, the advanced autopilot and radar of the new -2N, this fighter series is being improved for the third time at minimum cost and without interrupting Fleet readiness. This is "design growth." This is why, fighter for fighter, the *Crusader* has logged more peace-keeping flight hours than any other 1,000-plus-mph aircraft in U. S. service.

CHANCE VOUGHT AERONAUTICS DIVISION DALLAS, TEXAS



contain cobalt. Material substitution programs have been successful in partially reducing the residual radiation expected from engines like the X-211. However, the engines still will not be safe enough to be handled directly by maintenance crews.

The remote handling and maintenance of radioactive equipment and machinery has grown to such an extent in the U.S. nuclear industry in the last 15 years that it is now an everyday affair in most nuclear facilities. The background of experience in the use of shielded hot rooms, remote control manipulators for the assembly, disassembly and inspection of irradiated mechanical systems and shielded vehicles to transport hot articles is almost limitless.

General Electric has developed heavily shielded trucks equipped with manipulator arms especially for the remote controlled removal of direct cycle nuclear aircraft engines. The company has also demonstrated that it is possible to accomplish the necessary engine teardown and maintenance on a large scale in hot cells.

Radiation Shielding

Shielded trucks and hot cells will also be used to service indirect cycle engines if their reactor is not surrounded by a unit shield. A unit shield is very heavy and stops all of the radiation from the reactor. Nuclear-powered transport aircraft which carry human passengers will require a unit shield.

Air flow through the X-211 is approximately 300 lb. per sec., making it the largest known turbojet. High pressure drops in the reactor and in the ducts bending around the shields, which must be behind and in front of the engine, raise the optimum pressure rise for the compressor above 20 to 1. This probably is about the same compressor performance required for the indirect cycle engine. Although the indirect cycle has lower pressure losses in the engine and its duct system, it must provide a large volume of high pressure air to drive the heat transfer pumps.

Development progress on the indirect cycle turbojet engine system and on other systems in the nuclear ramjet, rocket, turbojet and turboprop fields has led to the belief among some engineers specializing in nuclear power that high power density reactors for flight propulsion units are easier to develop then other components of these systems. Longer leadtimes for pumps, valves and other equipment than for the reactors in some of these projects have led to this theory—but the direct cycle engine is a definite exception.

Even with the substantial growth in reactor technology produced by the ANP program over the past 10 years, design of the direct cycle aircraft reactor is considered a uniquely difficult problem. Its complexity has completely overshadowed that of the other components in the direct cycle system and of the handling equipment needed to service it.

GE Aft-Fan Engines Installed on Caravelle

General Electric Co. fits Sud Aviation Caravelle testbed transport with GE CJ-805-23C aft-fan engines. The short-cowl nacelles were designed and constructed by Douglas Aircraft, which is building Caravelle under license. This Caravelle is due for flight-test this month.

The best indication that General Electric has solved this formidable problem is that even the severest critics of the ANP program concede that today it is possible to fly a nuclear aircraft using a direct cycle engine.

Most of the difficulties with the direct cycle reactor have grown out of two major design requirements. These requirements are:

• **Operating life of 1,000 hr.** at fuel element temperatures above 2,000F in a highly oxidizing atmosphere and in severe radiation conditions. These demands on materials are the most severe in the whole reaction program today. Other flight propulsion reactors will have an operating life of less than 10 hr. except for the indirect cycle reactor which must meet the 1,000 hr. requirement but does not have the oxidation problem.

• **Use of a geometry** which will allow the core to serve as a radiator as well as a nuclear reactor. The large air passages needed to satisfy the radiator function also serve to self-shield the fuel elements. This means that very large amounts of fuel have to be put into the reactor to make the fuel mass critical. These voids also allow a large volume of high energy neutrons to stream out of the reactor.

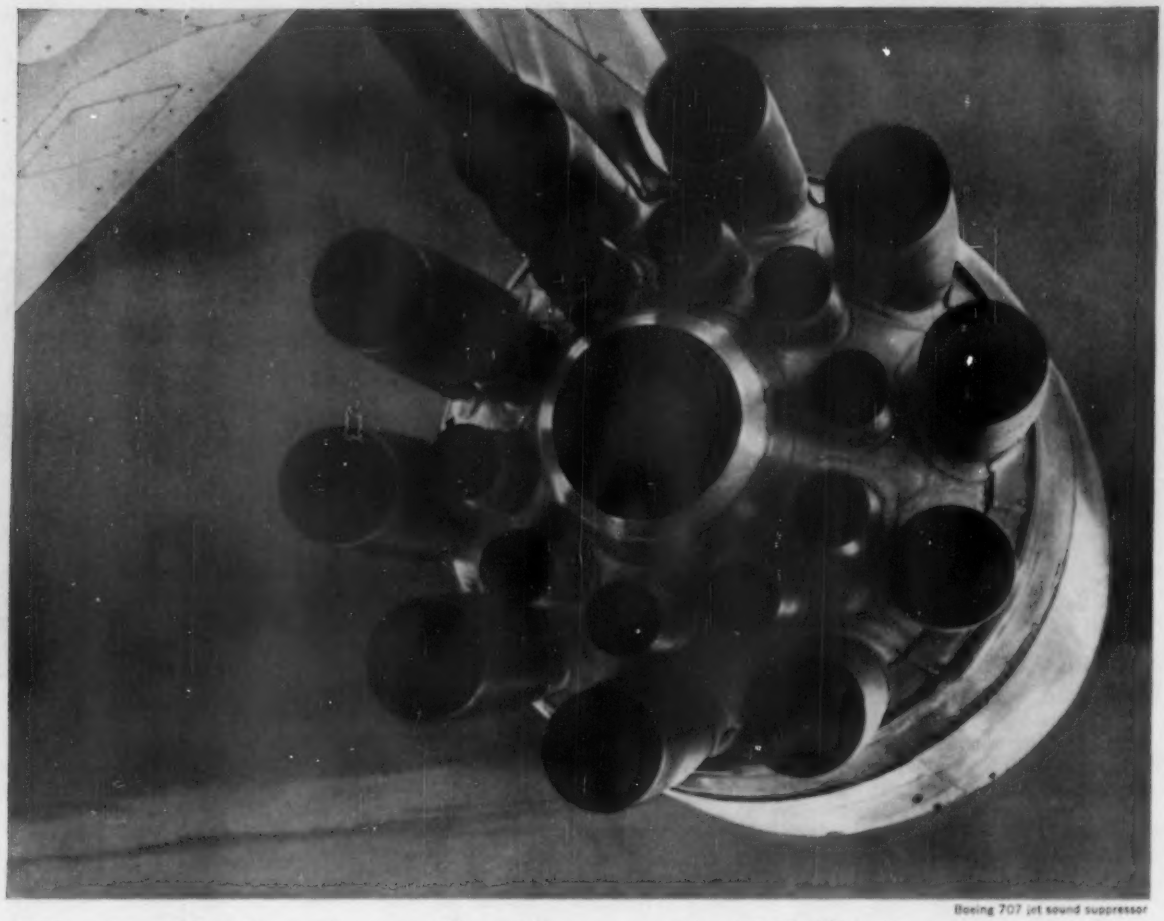
The presence of the large voids in the nuclear mass increases the number of design variables to almost intolerable proportions. The nuclear engineer designing the direct cycle reactor has to handle 60 separate design variables, each of which has upper and lower restraints on it. This is a considerably larger number of variables than are present in the basic calculations for other types of power reactors.

Design Complications

An industrial design task has rarely had this many tight constraints placed on it simultaneously. Usually, it is possible to isolate major portions of any problem and deal with them separately so that less than a dozen variables of importance are present in any calculation. This has not been possible with the direct cycle reactor.

Basically, all of the 60 variables have a direct influence on three factors, the control of which is the objective of reactor design. These factors are:

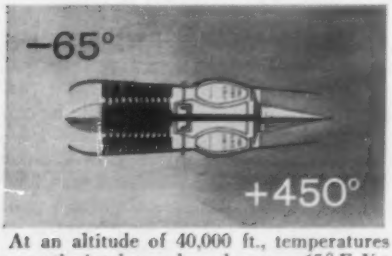
• **Power and temperature** distribution through the core. Maximum heat transfer efficiency is achieved when the temperature is constant radially across the



Boeing 707 jet sound suppressor

The oil that's safe through 500 degrees F:
HOW ESSO DOES IT!

Jet age aircraft make unprecedented demands on lubricants. Not even the most highly refined mineral oils are able to cope with the temperature extremes in turbine engines. Needed was a *synthetic* oil with good lubricity and stability at very *high* temperatures—and easy-flowing properties at very *low* temperatures. Esso was the first successfully to develop such an oil.



At an altitude of 40,000 ft., temperatures near the intake can be as low as −65° F. Yet in some of the highly-loaded bearings, with rpm up to 14,000, they may soar to 450° F.

Esso synthetic engine oils were ready *before* the first turboprop Viscounts entered commercial service. Esso Aviation Turbo Oils 35 and 15 were the first approved oils for *all* turbine-powered airliners. In fact, the development of these engines depended upon the availability of Esso Aviation Turbo Oils!

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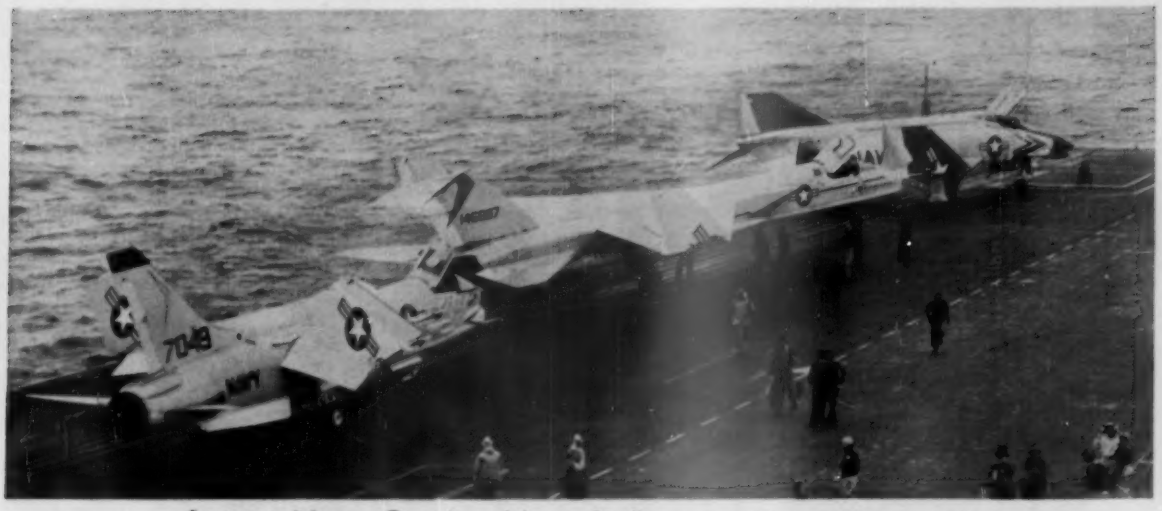


Latest Navy Carrier Aircraft Operate From Forrestal

Chance Vought Crusader F8U-2N, North American-Columbus A3J-1 Vigilante (with wingtips, top of tail and nose cone folded) and McDonnell F4H-1 Phantom II line up on port bow of USS Forrestal. The aircraft carrier spent 10 days off the Eastern Seaboard on new aircraft evaluation trials. North American, Chance Vought and McDonnell evaluated mobile aircraft-support vans on the Forrestal.

reactor. Longitudinally, it is best to have the temperature peaked slightly in the forward direction. It is difficult to achieve this ideal distribution, and some parts of the reactor receive more nuclear energy and run hotter than other parts. Maximum temperature in the reactor is then limited to the temperature of the hottest section to prevent structural failure and burn-out.

• **Criticality.** Putting the correct mass of fuel in a reactor with large voids has not proved easy. The correct mass must be put in or criticality will not be achieved and it is a zero-power reactor. The critical mass must be exceeded by a slight percentage to allow for the accumulation of poisons during operation which lower the effectiveness of the nuclear fuel and can make the reactor go subcritical and stop its power production.

• **Control.** The control effect of 20-30 boron control rods inserted into a highly self-shielding and non-homogeneous reactor is practically impossible to determine over the reactor's lifetime without a lengthy experimental program.

These three factors are completely interdependent, and no change can be made in any of them without affecting the other two.

Variables Considered

A partial list of the design variables which affect the temperature distribution, the criticality and the reactor includes: number of control rods, fuel tube diameter, spacing between fuel tubes compared with their radii, fuel distribution through the tubes in both the radial and longitudinal directions, fuel loading distribution throughout a large number of tubes, reflector material and reflector thickness.

It is possible to divide a large reactor measuring about 6 ft. in diameter and 6 ft. long, approximately the size of the X-211 reactor, into about 20 small sections for calculation purposes. Average values for all of the variables may be assigned to each section. Even when this is done, it is impossible to reduce the number of important variables in the design problem to fewer than 60.

Actually, the problem is more complicated than it might seem because some of the primary variables are heavily influenced by secondary effects which are not properly understood. A significant amount of power is generated in the reactor structure which holds the fuel tubes, in the moderator and in the reflector through radiation from the fission process and through secondary radiation emitted by the structure. This secondary power generation is large enough to invalidate all of the reactor design calculations if it is ignored. To date, it has not proven possible to predict secondary radiation level with a high degree of accuracy.

As a result of the large number of variables which must be considered simultaneously and the significant secondary effects in the reactor, two main tools are needed in reactor design. These are large digital computers and critical assemblies.

Sophistication and volume of the nuclear calculations now made on large computers probably would be impossible to duplicate with computation methods in use 10 years ago. The extremely complicated nature of these computer programs has spawned a new class of specialist who is an expert mathematician with a good knowledge of reactor physics. Computer capability is growing so rapidly that it probably would be more accurate to say that several new classes of specialists are developing who are concentrating on various phases of reactor dynamics.

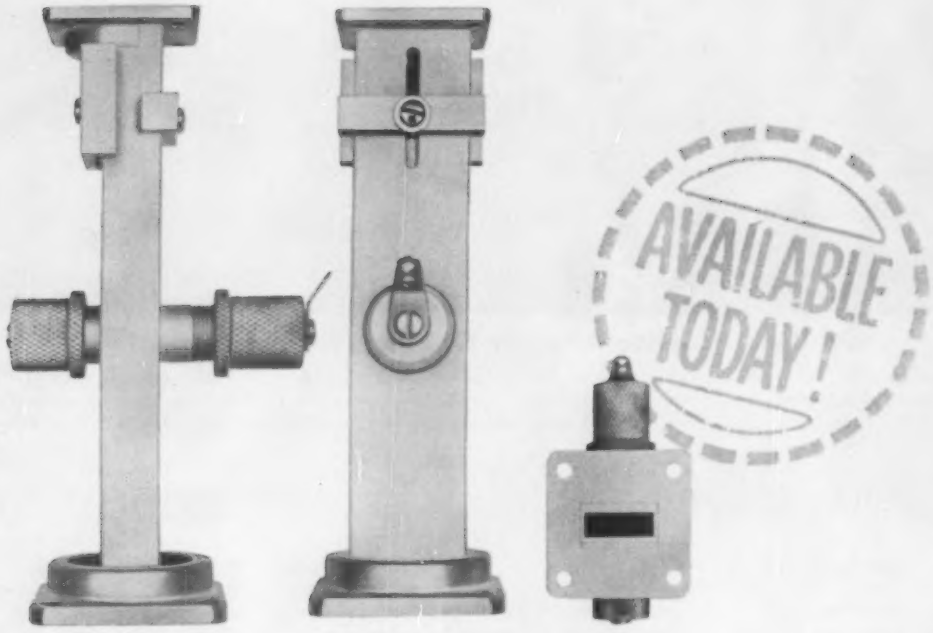
Ultimate Goal

While modern computers are making it possible to go into more and more detail in reactor design, the ultimate goal is to reduce the problem to its simplest terms. As the understanding of reactors grows, it should be possible to shorten the analysis required by combining the effect of several variables into a single mathematical expression. In this way, it is hoped that the general operational characteristics of a broad class of reactors may be investigated by a few simple equations.

A hundred or more reactor configurations currently must be studied, each through major computer programs, just to define the general design region for a typical direct cycle aircraft reactor. Finding the optimum reactor configuration in this design region is vastly more complicated.

Reactor technology cannot be advanced through computer work alone. The avalanche of data pouring from these machines must be checked and refined constantly by experiment and through observation of operating reactors. The experimental work is performed on critical assemblies. These are zero-power mockups which duplicate the characteristics of the power reactor as closely as possible.

Critical assemblies have fuel elements loaded with nuclear fuel with exactly



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- **Low pump power—50 milliwatts**
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- **Utilizes commercially available varactor diodes**

Specifications for X-Band Model 1019-A Parametric Amplifier.

Frequency Range	8600 to 9300 mc (tunable)
Bandwidth	30 mc
Gain (minimum)	17 db
Single Channel Radar Noise Figure	5.0 db including circulator
Pump Frequency	17,400 to 18,400 mc
Pump Power	25 to 50 milliwatts
Type of Operation	Quasi—degenerate
Weight	Less than 5 pounds
Size	190 cubic inches
*Unit Price	$6,998.00 each (less in quantity)
Delivery	90 days after receipt of order

*Price quoted above includes basic amplifier body, varactor diode, circulator, and klystron.

Specifications, price and delivery subject to change without notice.

the same dispersion patterns as the power reactor will have. Their moderator arrangements and general geometries are also about the same. These assemblies are never allowed to achieve a self-sustaining chain reaction so that they will not produce power.

A large number of nuclear measurements can be made on the critical assemblies which will verify or disprove most of the operating characteristics predicted for the power reactor. It is not possible to check everything with the critical assembly, however, and there is enough uncertainty in a design to make the first power checkout of a reactor a memorable occasion for its designers.

During the development of a new type of reactor, it has also been necessary to test experimental units which produce power. Use of new construction materials, new moderators, etc., in a new class of reactors usually makes it imperative to get power-on data before a reactor design is fixed.

General Electric has built three experimental power reactors as it moved toward the final design for a flight-weight, long-life direct cycle reactor. In all of these power experiments, two modified J47 turbojet engines were operated in series with the reactor. The reactor was heavily shielded and located to the side of the engines.

High-pressure air from the J47 compressors was fed by long ducts through the reactor and then back to the engines where it drove the turbines and was exhausted. This rig allowed simultaneous testing of turbojet parts, an integrated control system for the reactor and the turbojet, and the necessary accessories, as well as the reactor itself. These tests were designated Heat Transfer Reactor Experiments (HTRE).

HTRE Series

HTRE-1 first ran in 1956. The reactor in this experiment was the same basic type as all of those in this GE program. It was classed as a high power-density, heterogenous, thermal reactor, and its fuel was enriched U-235. Water was used as the moderator to slow the neutrons and keep their average energy in the thermal energy range, and to raise the probability that each of them would cause a fission reaction. Fuel elements in HTRE-1 were nickel-chrome clad, and the basic reactor structure was aluminum.

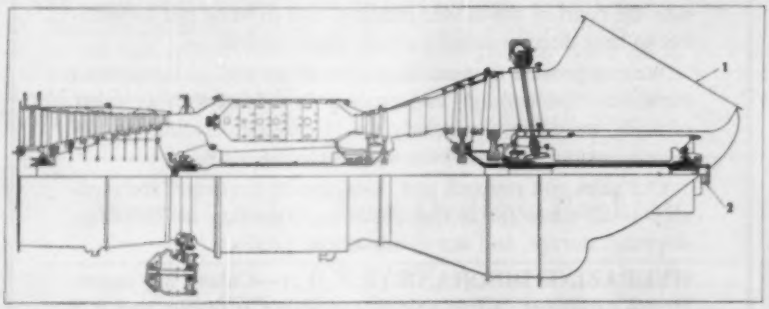
The core consisted of 37 tubes arranged in a hexagonal pattern, and the fuel elements were secured in the center of the tubes. Air from the engine compressor entered a plenum at the front of the reactor and passed through the tubes where it was heated by the fuel elements. The air left the reactor at temperatures as high as 1,400F while the water moderator circulating around the tubes kept them and the other aluminum structure below 300F. The reactor was operated a total of 230 hr. during HTRE-1, and its peak power was 14 megawatts—sufficient to operate a modified J47 turbojet on nuclear power alone.

HTRE-1 demonstrated the stability and controllability of the complete direct cycle engine system, but its growth potential was limited by its water moderator. High performance systems which would operate at high temperatures require a solid moderator.

Development of the solid moderator and reactor construction materials which would be satisfactory at high temperatures was facilitated by modifying the HTRE-1 core. The basic core size of approximately 60 in. in diameter and 55 in. long was retained but the center seven tubes were removed, leaving a hexagon-shaped hole 11 in. on a side. It was possible to test a wide variety of fuel elements, moderators, construction materials and instrumentation in this space. This new reactor assembly was designated HTRE-2 and it began operation in 1957. It is still in use and has operated over 1,500 test hours.

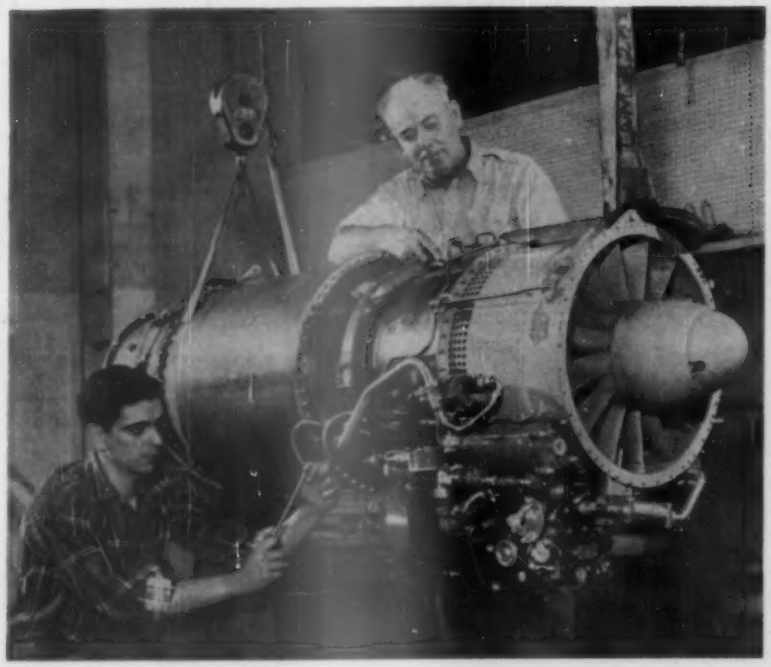
First Solid Moderator

The first solid moderator and first ceramic fuel element reactor sections were tested in HTRE-2. The most promising solid moderator apparently is zirconium hydride. The first zirconium hydride moderator tested by General Electric contained as much hydrogen as water and could operate at a much higher temperature. More recently, forms of this basic material



Pratt & Whitney Delivering Production JT-12s

Pratt & Whitney is delivering production versions of the JT-12 lightweight turbojet engine, which weighs 436 lb. and delivers 3,000 lb. thrust. The JT-12 has accumulated 7,700 hr. of development time, including 98 hr. in a flying testbed. Engine also has been flown 700 hr. by airframe manufacturers. The JT-12 has been selected to power the Lockheed JetStar, North American T-39 and Canadair CL-41 trainer. Line cut above shows JTFD-12 shaft version which will be installed in Sikorsky S-64 helicopters.



Propellant Briefs from Callery Chemical Company

RESEARCH AND DEVELOPMENT CAPABILITIES—Callery Chemical Company has pioneered the research and development of high energy fuels, propellants and advanced energy concepts. We are continuing aggressively to research and develop even newer concepts of chemical energy for use in solid and liquid fuels, mono-propellants, solid and liquid oxidizers, and space exploration.

This diversification of effort in the interests of National Defense can be helpful to you. We recently opened a new laboratory and office in Encino, California, to provide closer liaison with the heart of the missile industry, and to bring our capabilities to bear directly where they are most needed.

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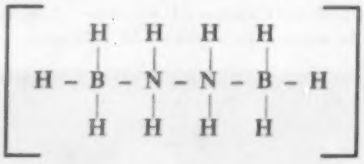

It is a white, crystalline, free-flowing powder of uniform high purity.

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Washington, D. C.
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High Speed Heating

Moscow—Surfaces of the Soviet E-66 single turbojet, delta-wing aircraft were burnt a slight brownish color during its recent flight over a 100 km. closed course at 1,334 mph. (AW Dec. 5, p. 39). Soviets report surface temperature increased more than 100C and "considerably exceeded the water boiling point" during the flight, and the aircraft's skin "had become slightly brownish" from heating when it landed. The E-66, believed to be the Sukhoi-15 Fishpot fighter, flew 31 min. at 44,291 ft., including less than 170 sec. on the closed course.

have been developed which contain much more hydrogen than water and are therefore better moderators for a given weight.

Beryllium oxide and other ceramic fuel elements have been tested in HTRE-2. While these ceramic fuel elements have a high maximum operating temperature, they also release fission fragments and contaminate the air going through the reactor. Two approaches which have been taken as possible cures for this problem are cladding of fuel elements to prevent the escape of fission fragments and the use of electrostatic filters to prevent them from leaving the engine.

Third Test Reactor

Third test reactor in the General Electric program was the first to approach the characteristics needed for flight. This reactor was designated HTRE-3. Its core was mounted in a horizontal position, and its structure was designed for flight loads. The core consisted of 150 hexagonally shaped zirconium bars approximately 60 in. long, nested together to form a solid mass. Each of these moderator rods had a round hole down its center. The nickel-chrome alloy fuel elements in which the nuclear fuel was distributed had a smaller outside diameter than the bore diameter on the moderator rods.

Fuel elements were secured in the center of the moderator rods, leaving 150 long ducts for engine air to pass through the reactor and along the fuel elements. The reactor was completely air-cooled, as it would be on an aircraft. Cooling air which passed through the reactor structure was mixed with the air passing along the fuel elements, and the combined flow drove the turbine.

A flight weight shield was placed around the reactor for testing purposes. An additional shield also was provided to allow certain test adjustments and measurements to be made near the HTRE-3 assembly without danger to

the test crew and instrumentation.

HTRE-3 was run for the first time in September, 1958. An over-temperature accident damaged the assembly, but it was repaired and run again about a year later. All of the tests first planned with HTRE-3 have been completed, and the reactor has operated for a total of 120 hr. Of this, 65 hr. have been continuous turbojet.

Maximum power operation with HTRE-3 has brought impressive results. Air temperature out of the reactor was about 1,600F, and 35 mw. of power was developed. Two modified J47 turbojets were operated in combination with the reactor in HTRE-3. Only a small amount of thrust was produced since the objective was simply to test the reactor at full power in combination with a turbojet.

Control System

Control system for the direct cycle nuclear aircraft engine is considerably more complicated than the control system needed on a chemically-fueled turbojet.

It is considered possible today to build a one-lever control for the pilot to operate the nuclear engine, but this has not yet been achieved in practice.

Basically, the differences in control systems are due to different response times to power setting changes. The burner section on a chemical turbojet responds almost instantaneously to increased fuel flow, while the response of the nuclear reactor to a change in control rod position is not as fast in most cases. The nuclear engine also is more subject to metallurgical limits in its structure. These may be so high that the rate of change in engine power may be reduced to the point that compressor stall, which normally limits engine acceleration, may no longer be a factor.

Control systems undoubtedly will have to be tailored to the mission requirement of the nuclear aircraft. A variety of systems are possible which will link the reactor and the rotating machinery of the engine and provide different responses.

FAI Approves 12 Soviet Flight Records

Paris—An unlimited world record and 12 international class records established last May, June and July by Soviet pilots and a parachutist are among those approved recently by the Federation Aeronautique Internationale.

Officially recognized Russian marks are:

• **Delta-Wing F-405** turbojet aircraft, flown by B. Adrianov at a speed of 2,092 kph. (1,299 mph.) over a 100 km. closed course May 28, 1960. This was the only unlimited class record set.

• **Mi-1 single rotor** helicopter, flown by F. Belushkin at average speed of 141.392 kph. (87.8 mph.) over a 1,000 km. closed course June 24, 1960. Record set in Class EID, for reciprocating-engine-powered rotary wing aircraft in the weight range 1,750 kg. to 3,000 kg. 3,855 lb. to 6,613 lb.) class.

• **Mi-1 flown** by T. Russiyan at an average speed of 142.642 kph. (88.58 mph.) over a 500 km. closed course June 18, 1960—a women's record.

• **A-10 two-place sailplane** flown by V. Ilchenko a distance of 607.942 km. (355.5 mi.) to a predetermined destination June 18, 1960.

• **A-10 sailplane** flown by V. Ilchenko at a speed of 96.12 kph. (59.69 mph.) over a 100 km. triangular course.

• **A-15 single place sailplane** flown by M. Veretennikov at an average speed of 111.388 kph. (69.17 mph.) over a 100 km. triangular course June 6, 1960.

• **A-15 sailplane** flown by M. Veretennikov a distance of 714.023 km. (443.4 mi.) to a predetermined destination June 18, 1960.

• **Nighttime parachute** jump (undelayed opening) by P. Dolgov from an altitude of 12,974 meters (42,567 ft.) on June 3, 1960.

• **Daytime parachute** jump (undelayed opening) by P. Dolgov from an altitude of 14,835 meters (58,673 ft.) on June 7, 1960.

• **M-1 helicopter** flown by Anna Gueppennere a distance in a straight line of 547.671 km. (340.322 mi.) June 25, 1960—a women's record.

• **M-1 helicopter** flown by T. Russiyan a distance in a closed circuit of 503.298 km. (312.749 mi.) June 18, 1960—a women's record.

• **Diamond sailplane** flown by A. Samosadova at an average speed over a closed 100 km. triangular course of 93.103 kph. (54.854 mph.) June 27, 1960—a women's record.

• **A-15 sailplane** flown by A. Samosadova at an average speed over a closed 200 km. triangular course of 73.404 kph. (45.613 mph.) July 15, 1960.

Aircraft Sales, New Orders, Backlog

(Millions of dollars)

Product	Backlog June 30, 1960	Net new[1] orders during quarter	Net sales during quarter	Backlog Sept. 30, 1960
Total	11,991	3,065	2,593	12,463
Complete aircraft and parts	6,052	1,388	1,249	6,191
For United States military customers	4,168	1,018	802	4,384
Other	1,884	370	447	1,807
Aircraft engines and parts	1,337	540	277	1,600
For United States military customers	1,009	482	193	1,278
Other	328	58	84	322
Aircraft propellers and parts	89	21	19	91
For United States military customers	82	13	13	82
Other	7	8	6	9
Other products and services	4,543	1,116	1,048	4,611

[1] New orders received during quarter less terminations during quarter. Data for terminations are not shown separately to avoid disclosing figures of individual companies.

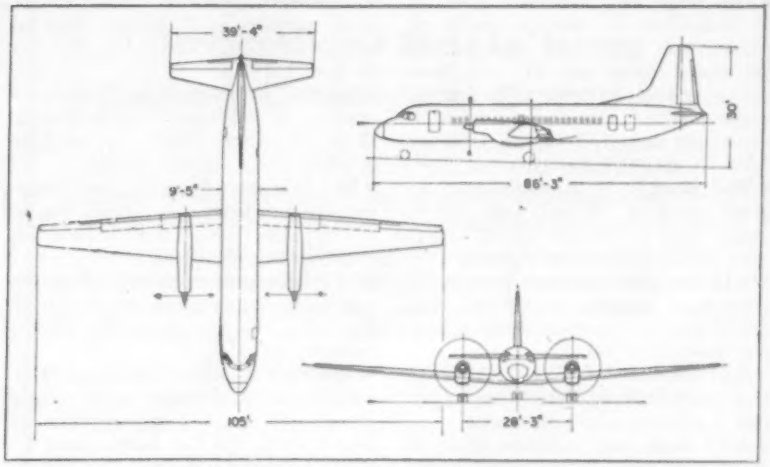
Value of Backlog Reported by Manufacturers of Complete Aircraft, Aircraft Engines, and Propellers: Third Quarter 1959—Third Quarter 1960

(Millions of dollars)

Product	Quarter ending				
	Sept. 30, 1959	Dec. 31, 1959	Mar. 31, 1960	June 30, 1960	Sept. 30, 1960
Total	12,058	12,120	12,229	11,991	12,463
Complete aircraft and parts	7,018	6,650	6,797	6,052	6,191
For United States military customers	4,635	4,419	4,714	4,168	4,384
Other	2,383	2,231	2,083	1,884	1,807
Aircraft engines and parts	1,580	1,385	1,374	1,337	1,600
For United States military customers	1,151	985	1,018	1,009	1,278
Other	437	400	356	328	322
Aircraft propellers and parts	88	87	89	89	81
For United States military customers	80	48	81	82	82
Other	12	9	8	7	9
Other products and services	3,384	4,028	3,990	4,843	4,611

Source: Bureau of the Census, Industry Division.

Japan's YS-11 to Roll Out By End of 1961



WING AREA of the YS-11 is 1,020 sq. ft. Wing loading is 49.4 psf. Aspect ratio is 10.8.

YS-11 Basic Performance Data

Engine:	
Rolls Royce, Ltd.	Dart R.Da.10/1
Takeoff horsepower	(Dry) 2,660 ehp. (Wet) 3,060 ehp.
Propeller:	
Rotol, Ltd.	4-blade, hydraulic, constant-speed, feathering and reversible
Diameter	14 ft. 6 in.
Number of seats:	52-60
Dimensions:	
Span	105 ft.
Length, over-all	86 ft. 3 in.
Height	30 ft.
Fuselage maximum width	9 ft. 5 in.
Main Wing:	
Wing area	1,020 sq. ft.
Aspect ratio	10.8
Landing Gear:	
Wheel base	30 ft. 11 in.
Tread	28 ft. 3 in.
Loadings:	
Wing loading	49.4 psf.
Power loading	8.20 lb./ehp.
Weight:	
Basic operational weight	31,217 lb.
Fuel, oil, water-methanol	8,069 lb.
Payload	10,318 lb.
Manufacturer's weight allowance	661 lb.
Takeoff weight	50,265 lb.
Maximum landing weight	48,047 lb.
Maximum fuel weight	12,210 lb.
Performance:	
Cruising speed/altitude	257 kt./20,000 ft.
Range, 52 passengers	580 naut. mi.
Maximum range/payload	1,290 naut. mi/5,400 lb.
CAR takeoff field length/takeoff weight	
at ISA	2,890 ft./50,265 lb.
at ISA + 23C	3,200 ft./50,265 lb.
CAR landing field length/maximum landing weight	
at ISA	3,790 ft./48,047 lb.
at ISA + 23C	3,790 ft./48,047 lb.

Tokyo—First prototype of the Nihon YS-11 twin turboprop transport is expected to be completed by the end of next year under a $12 million development program calling for production of four aircraft for flight, static load and fatigue testing.

Design and manufacture of the YS-11 (AW Dec. 22, 1958, p. 27) is being carried out by Nihon Acroplane Manufacturing Co., Ltd., established in June, 1959, as a joint venture of the Japanese government and private corporations to succeed the Transport Aircraft Development Assn., which initiated the YS-11 project in 1957.

Since its establishment in 1959, Nihon has received government subsidies of $10.7 million, and is requesting an additional $3.3 million for the YS-11 program for 1961.

Designed for short-range operations over stage lengths of 300-600 naut. mi., the YS-11 will accommodate 52-60 passengers—approximately twice the capacity of a Douglas DC-3—and will incorporate a short takeoff and landing performance that will make possible a takeoff run of less than 3,000 ft., or only 70% that of the DC-3 while carrying twice as much payload.

Dart Powerplants

The YS-11 will be powered by two Rolls-Royce Dart R.Da.10/1 turboprop engines, developed by Rolls-Royce especially for the YS-11 by increasing the power of the Dart R.Da.7 engine. Each engine develops a takeoff horsepower of 2,660 ehp.; with water injection added, power is increased to 3,060 ehp. Powerplants will be fitted with Dowty Rotol reversible-pitch propellers measuring 14.5 ft. in diameter to provide high thrust at takeoff.

In standard configuration, passengers will be seated four abreast in 13 rows, giving a maximum payload of 10,318 lb. over a stage length of 580 naut. mi. at a cruising speed of 250 kt. Seats, which are mounted on rails, can be rearranged to accommodate 60 passengers seated four abreast, giving a payload of 11,906 lb. for a stage length of 330 naut. mi. YS-11 has a maximum still-air range of 1,290 naut. mi. with a payload of 5,400 lb. representing 27 passengers. All operations include fuel reserves for 45 min. in a holding pattern at 5,000 ft.

Fuselage of the YS-11 is pressurized to maintain a cabin altitude of 8,000 ft. at a flight altitude of 20,000 ft. Cabin has no partitions, thereby providing the operator with flexibility in making interior arrangements. Air conditioning will maintain a cabin temperature of 65-80F.

The first production YS-11 is ex-

46,000 rpm turbine starter "winds up" on . . .

FAFNIR BALL BEARINGS

On the turbine end of Hamilton-Standard's PS400-14 jet engine starter, Fafnir Super-Precision Ball Bearings hold the turbine steady at 46,000 rpm. The bearings themselves are engineered to meet testing speeds of up to 84,000 rpm!

From the moment the starter is energized, these extra-high-speed ball bearings are subjected to punishing service. Designed with "counterbored" inner rings for efficient high-speed performance, they must operate dependably and precisely under thrust loads of up to 350 pounds per bearing.

Engineering and production capabilities of the first order turn out bearings for service like this.

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BALL BEARINGS

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Please send me more information on aircraft accessory bearings.

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The tremendous weight and speed of modern airliners call for a runway pavement that meets every strength and safety requirement.

Built from the ground up for jets! Dulles International Airport near Washington, D. C. will handle peak traffic day after day. Runways stretch more than two miles long. High-speed turnoffs sweep planes clear of the runway within 30 seconds of touchdown. *All runways and taxiways are designed to handle aircraft weighing up to 500,000 pounds!*

Only concrete could do the job. It's the one pavement that enables engineers to accurately design runways to match *any* traffic load. Pilots prefer concrete, too. Safety is built in. There is dependable skid resistance, wet or dry. Light color for highest visibility. A surface that stays forever flat.

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Why concrete was specified at Dulles!

Concrete and asphalt were compared on nine engineering requirements. Concrete excelled on every count:

- Minimum acceptable life of 25 years
- Positive resistance to jet fuel spillage and jet engine blast
- Prevention of "shoving" as a result of high-speed turns
- Satisfactory performance under extremely high tire pressures
- Light-reflecting quality of the pavement
- Elimination of rutting of the pavement due to channelized traffic
- Skid resistance
- Only nominal maintenance required
- Adaptability of pavement to accommodate probable characteristics of future aircraft

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FOR RUNWAYS WITH A SOLID FUTURE...
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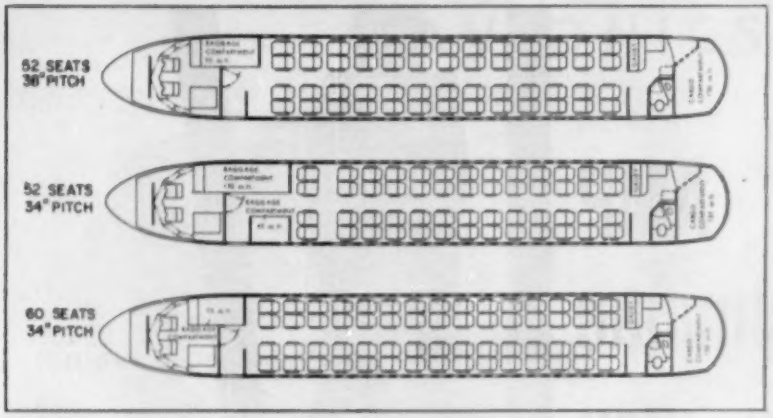


YS-11 CAPACITY of 52-60 passengers is about twice that of Douglas DC-3. The YS-11 will incorporate short takeoff and landing performance that will make possible a takeoff run of less than 3,000 ft., or only 70% that of the DC-3 while carrying twice the payload.

pected to be operating on domestic services in Japan in the summer of 1963.

Designs for a military version, the YS-11M, have been submitted to the Japanese Self Defense Agency. A survey made by the Ministry of International Trade and Industry estimated that 150 YS-11s would be produced between 1963-1970 to meet domestic needs, an anticipated export demand and national defense requirements.

Government Sponsorship

Although no Japanese carriers presently are planning to purchase the YS-11 for domestic or international service there is a possibility that companies such as Japan Air Lines and All Nippon Airlines may buy the YS-11 if the project proves successful, since Nihon Aeroplane–the manufacturer–is sponsored largely by the Japanese government.

According to a spokesman for JAL, "there is a possibility of purchasing them if the YS-11s meet all flight requirements for the domestic lines."

Liberal Indian Terms Sell Soviet Aircraft

New Delhi–Liberal Soviet financing is cited by the Indian government as the primary reason the Indian air force is concentrating on Russian-built transports and helicopters to strengthen northern frontier areas against Communist Chinese threats.

The Indian government has bought an Mi-4 helicopter and an An-12 turboprop transport. The purchase is expected eventually to total 10 Mi-4s and a dozen An-12 transports. They will be operated by the air force, but they are being purchased by the Border Roads Development Board, which is responsible for building roads and improving communications in the troubled northern areas.

Terms of the Mi-4 purchase call for a price of about $200,000, with payment accepted in Indian rupees. India doesn't feel this price was a special concession to make the sale, but officials praised the Soviet willingness to accept rupees as a "most practical" approach. The rupees paid for the Mi-4 are expected to be spent eventually for Indian export products. The An-12 was bought under similar terms.

Border Roads Development Board is buying the Russian aircraft with funds from the Indian air force budget, but board officials deny that the Soviet purchase was made purely for military purposes. They say it is part of an effort to improve general communications in "one of the few areas not improved by the British."

Indian Prime Minister Jawaharlal Nehru emphasizes the gravity of Indian-Communist Chinese disputes, especially in the inaccessible Pakistan, Nepal and Kashmir border areas, in explaining the need for aircraft capable of operating at high altitude. He said that "we are quite worried since this area is extremely difficult to reach and is situated in an undeveloped area 19,000 to 20,000 ft. up in the mountains."

Nehru said concern over this situation has spurred the government to improve all means of communications in these areas.

India also has bought two turbine-powered Sikorsky S-62 helicopters to operate at high altitudes. These machines cost $308,000 each, not including spares. The Indians are continuing evaluation of other helicopters, including the Sud Alouette II and III which recently completed six weeks of evaluation flights. Bell Helicopter has been discussing demonstrations with its 47G-3 machine.

All orders for foreign helicopters signed so far carry a clause giving the Indian government the right to manufacture the aircraft in India if it should decide to establish production facilities in the future.

Singapore Airport Plans Aviation Trade Show

Singapore–Nine-day international air show, the first of its kind here, will be held at the Singapore Airport beginning Apr. 8, 1961. The show will be sponsored by the Singapore government and will feature static and flying displays of civil and military aircraft. On the first day, Singapore Airport's new operations building will be officially opened.

The show's static displays will cover seven acres of the airport and will include aircraft accessories, and avionic and airfield equipment shown by more than 200 exhibitors including manufacturers from Germany and Japan.

Three days of the show will be devoted to aerial displays of military fighters and bombers and military and civil helicopters and lightplanes.

PRODUCTION BRIEFING

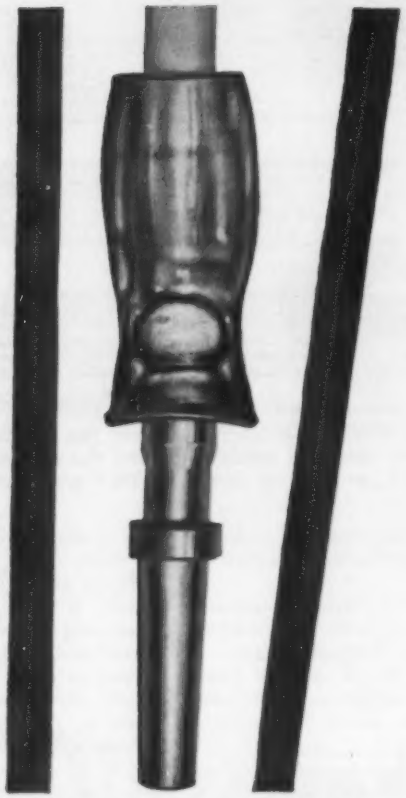
Vitro Electronics, a division of Vitro Corp. of America, has been awarded an $885,000 contract by the Navy to install its Nems-Clarke 1400-1 FM/FM missile-satellite monitoring system and its Nems-Clarke AMR-100 intra-ship communication system on the Niantic Victory and the Knox Victory, two ships of the Pacific Missile Range Fleet.

Republic Aviation Corp., Farmingdale, N. Y., will expand its tape-controlled machine tool operations with the addition of 10 automatic machines worth $10 million. The tape-controlled milling machines, part of the tooling for F-105D production, are said to play a part in the continuing cost-reduction program on the aircraft.

Lamtex Industries, Farmingdale, N. Y., will develop rocket motor cases for the second stage of the Lockheed Polaris fleet ballistic missile. The rocket cases utilize the company's Hystran, filament-wound, fiber glass reinforced material, which is said to afford a 50% weight saving over steel cases.

Doman Helicopters, Inc., Danbury, Conn., is producing structural components for the re-entry vehicle of the Minuteman ICBM under subcontract from the Lycoming Division of Avco Corp. The contract is one of several new projects acquired by Doman.

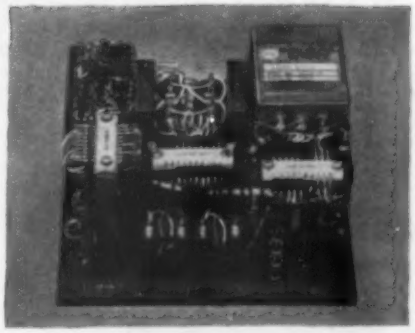
AMP taper technique points the way to greater reliability



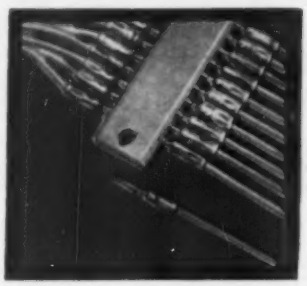
Magnetic Amplifiers, Inc. of New York carefully manufactures its Static Inverters with a step-by-step quality control and testing program to build in the reliability required for aircraft and missile applications.

It found that AMP Taper Technique simplified this procedure. A high speed AMP Automachine pre-terminates circuit leads with crimp-type, pre-insulated solid Taper Pins. Components are then easily tested in the modular stage before final assembly. Crimping eliminates difficult soldering operations and the danger of burning wound components while Taper Technique permits checking and trouble shooting without destroying the main cable. After final assembly, when the Pins are inserted into the Blocks, this Technique provides rugged vibration resistance and operational reliability.

AMP solderless Taper Pins are made in formed and solid types, with or without pre-insulation and mate with a wide range of one or two piece stackable Taper Blocks. You'll find that AMP Taper Technique is ideal for *your* quality control or circuit density problems too.



Magnetic Amplifiers' 250VA Static Inverter Model SIS-425041



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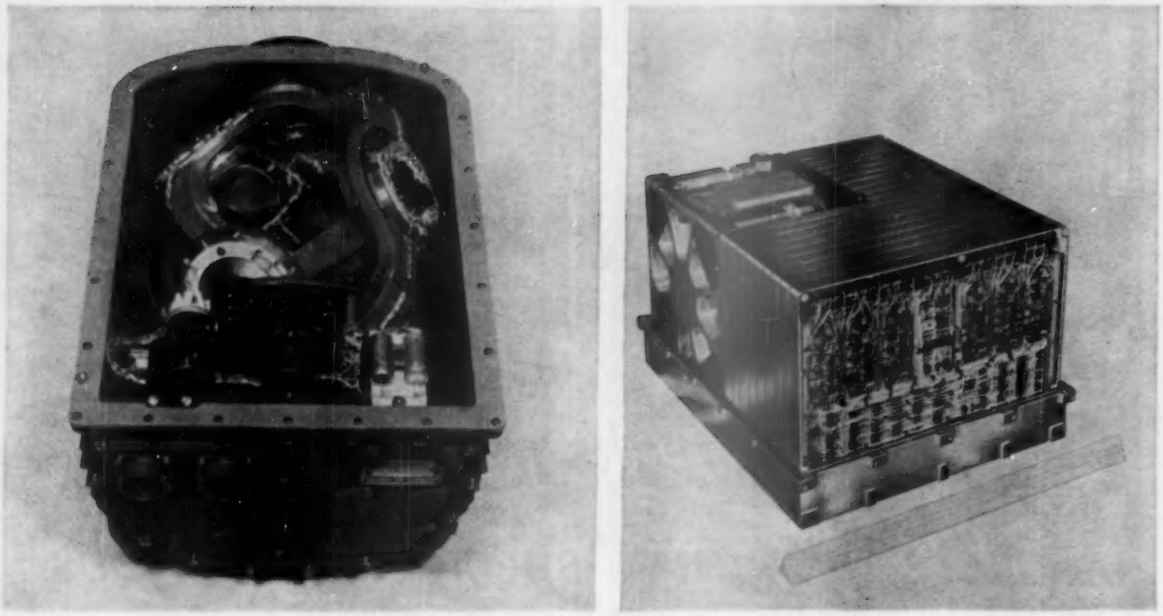

INERTIAL GUIDANCE SYSTEM to be used on Atlas-Centaur vehicle for lunar and interplanetary missions and for placing communication satellites in synchronous equatorial orbits employs a Minneapolis-Honeywell stabilized platform (left) and a Librascope digital computer.

First Details of Centaur Inertial Guidance

Washington—First details of the inertial guidance system to be used on the Atlas-Centaur for lunar and interplanetary missions were reported here recently by Dr. Donald L. Farr of Convair-Astronautics. System also can be used with Centaur to place a communications satellite in a synchronous (22,300 mi.) equatorial orbit.

The Centaur inertial system includes a four-gimbal gyro-stabilized platform built by Minneapolis-Honeywell and a digital computer provided by Librascope, a division of General Precision.

Factors in Choice

The relatively short time available to Convair to produce the Centaur, coupled with budgetary considerations, were primary factors in the choice of the Honeywell platform and the Librascope computer, Farr told the American Rocket Society annual meeting.

This meant using essentially existing hardware, which is expected to have an important byproduct advantage of providing a system with high reliability. The basic design of the Honeywell platform originally was developed several years ago for high-performance aircraft/missile applications, while the Librascope computer is an adaption of the AN/ASN-24 developed two years ago under Wright Air Development Division sponsorship (AW May 25, 1959, p. 124).

The function of the Atlas-Centaur guidance system for an interplanetary mission is to provide vehicle attitude information to the autopilot during launch and subsequent powered phases of flight, initiate engine cutoff commands and develop steering signals for injecting the Centaur into the required hyperbolic escape orbit.

The system must possess high reliability for moderately long periods of time, particularly when used to place a satellite in a synchronous orbit where prolonged coasting periods are required to obtain orbital altitude and desired longitude over the equator. To accommodate the wide variety of missions which are presently planned, the system also has to have considerable flexibility.

Attitude Freedom

The choice of the four-gimbal stabilized platform allows complete vehicle attitude freedom during its various thrust periods and during coasting periods so the vehicle can be oriented with respect to the sun, if desired.

The Honeywell platform with its four-gimbal construction weighs 32 lb. and uses three Type GG-49-D6 miniature single-axis floated integrating gyros. This gyro has been manufactured in moderately large quantities and used on other programs, assuring high reliability, Farr said.

Prior to launch, the platform is aligned and maintained to an earth-fixed reference, but during actual flight the platform is stabilized to inertial space.

Vehicle acceleration along its three axes is measured by three miniature floated intergrating accelerometers, Type GG-116A-2.

This is a modified version of the Honeywell GG-56 adapted to operate in a pulse-rebalance mode for use with a digital computer. Accelerometer output is in the form of a series of pulses in which each pulse is equivalent to a velocity of 0.1 fps.

Control Circuits

Control circuits for the stabilized platform, completely transistorized, are contained in three associated packages. One, weighing 18 lb., includes stabilization amplifiers and isolation amplifiers for the platform pick-off resolvers, as well as switching functions required during pre-launch alignment. The second, weighing 50 lb., contains pulse rebalance circuitry for the three accelerometers and various power supplies. Farr said the weight of this unit could be reduced for future applications. There also is a 10 lb. "signal condi-

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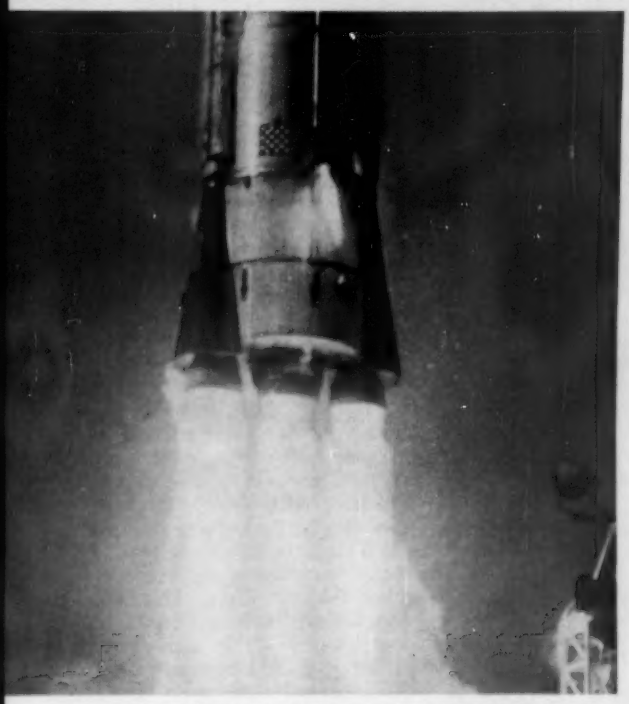
FLUOROCHEMICALS FAMILY *breaks performance barriers in many "special" space jobs!*

3M specialty chemicals set new limits for dielectric coolants, damping fluids, all-environment sealants, corrosion-fighting plastics and elastomers

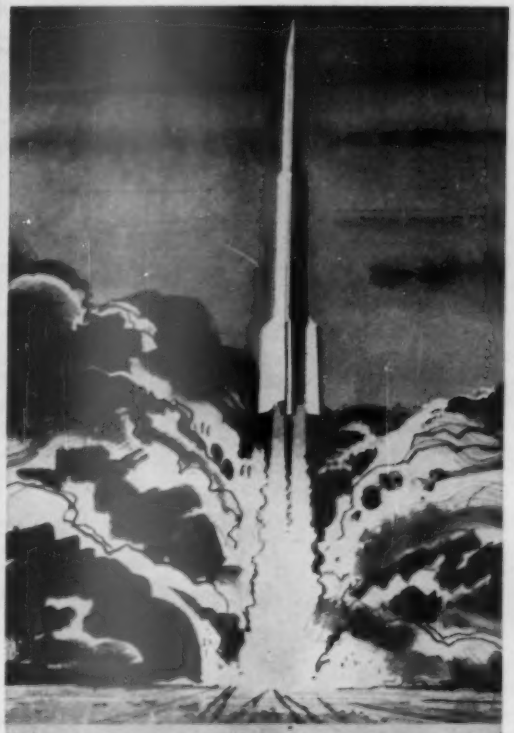
The race into space requires a whole world of *special* materials—with new strength, longer life, new immunity to attacks from extreme high and low temperatures, corrosive fuels, and new environments. 3M Fluorochemicals answer many of these new demands on materials. They are an entirely new *class* of chemicals that offer unique space-oriented properties allowing missile and aviation men to surpass limits of yesterday's materials.

For creating today's space craft, for designing tomorrow's . . . 3M Fluorochemicals offer new chemical, thermal and dimensional stability . . . while adding flexibility, long life and new strength to many parts, assemblies and systems. And 3M research is still expanding this exciting chemical frontier. Here at work are some outstanding 3M Fluorochemicals.

3M BRAND INERT FLUID FC-75 cools electronic countermeasure system. For critical heat transfer where extreme temperatures, corrosion resistance and high dielectric strength are required . . . FC-75 and FC-43 fluids are completely inert, immiscible, with extremely low solubility. They have great thermal stability, extremely low pour points. What hot design problem can FC-75 and FC-43 cool off for you?

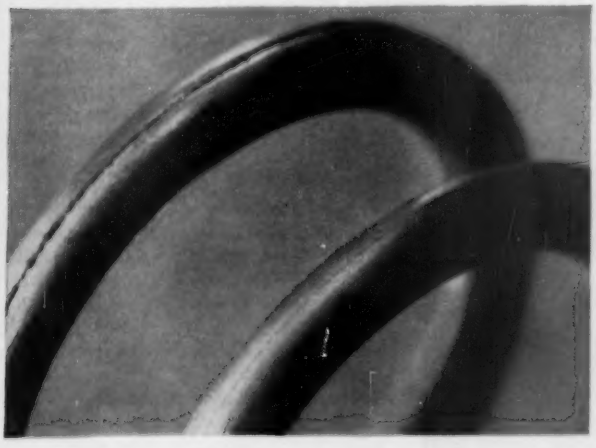


KEL-F® BRAND PLASTIC seals missile fuel valves. KEL-F Plastic is used for liners and sealers in the swivel mechanism of ball joints used in GSE equipment for ballistic missiles. It was primarily selected for its ability to withstand the corrosive action of LOX and JP fuels 3, 4 and 5A. Seals made of KEL-F Plastic won't shatter in extreme cold nor melt at temperatures as high as 390° F. KEL-F Plastic offers excellent flexibility plus high impact and compressive strength. How can it help you?



KEL-F® BRAND OILS are used here with a diaphragm made of KEL-F Plastic in pressure pickups used for highly corrosive fluid flow lines. These dense oils combine excellent load-bearing characteristics with chemical inertness, unusual corrosion and heat resistance, and high dielectric strength. This product is available in grease and wax form as well as oil and can be custom-tailored to conform to rigid specifications and standards. What critical need can these KEL-F products meet for you?

NEW FLUOREL® BRAND ELASTOMER 2141, with an unmatched Mooney scorch rating, permits processors to make fast, economical cures . . . like the O-ring of Fluorel, right, which is free from defects of other elastomer O-ring, left. Fluorel Elastomer withstands 400° F. for long-term service . . . 600° F. for short periods—remains stable in the presence of most fuels, lubricants and hydraulic fluids used in missiles. What problem can 2141 solve for you?



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CARDOLITE® Brand Resin Flexibilizer for potting and encapsulation • 3M Brand Paint Primer Concentrate for high-strength, non-pigmented primers • KEL-F® Brand Elastomers • CARDOLITE® Brand Friction Components for brake linings, clutch facings, other friction surfaces. For technical information about any of these 3M products, write 3M Chemical Division, Dept. KAW-120, St. Paul 6, Minnesota.

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CHEMICAL DIVISION

MINNESOTA MINING AND MANUFACTURING COMPANY

. . . WHERE RESEARCH IS THE KEY TO TOMORROW

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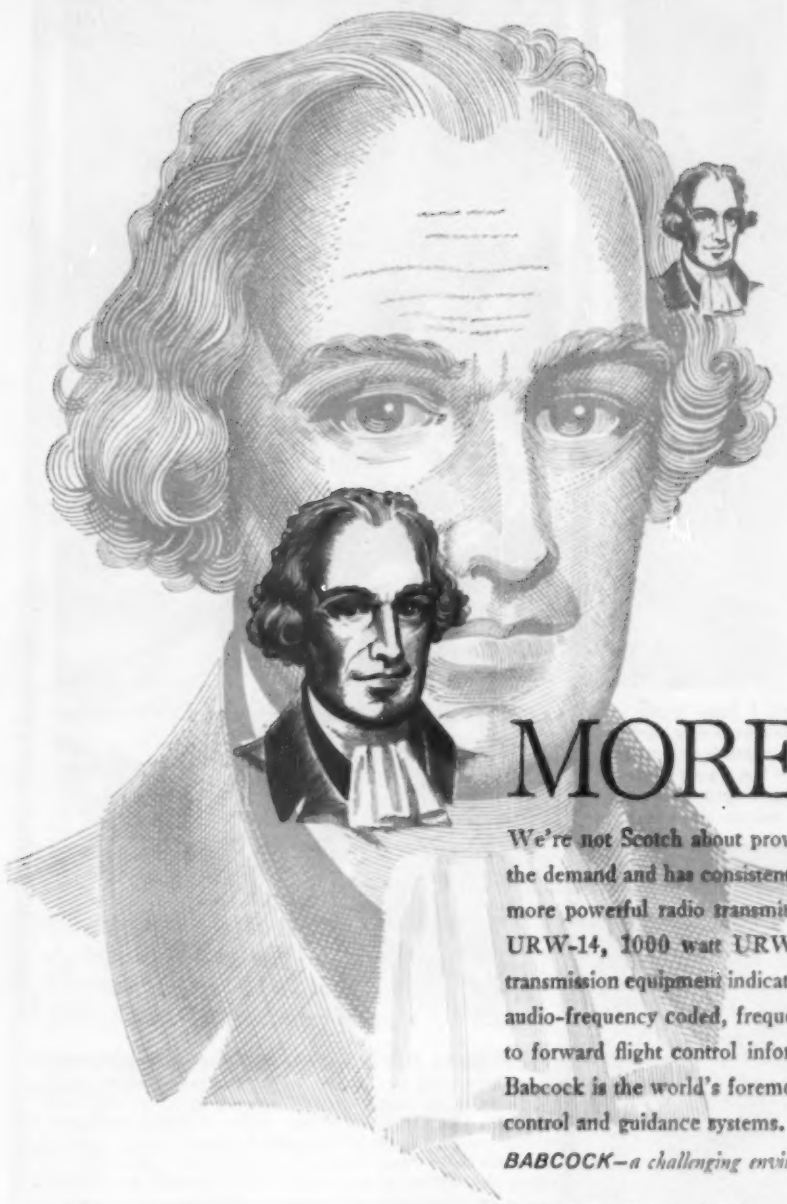

MORE WATTS

We're not Scotch about providing Watts. Babcock has kept up with the demand and has consistently been increasing its capability to supply more powerful radio transmitters. The 30 watt ARW-66, 100 watt URW-14, 1000 watt URW-15 and development of 10,000 watt transmission equipment indicates the trend. With such instrumentation, audio-frequency coded, frequency-modulated r-f signals are provided to forward flight control information to unmanned airborne vehicles. Babcock is the world's foremost designer and manufacturer of remote control and guidance systems.

BABCOCK—a challenging environment for interesting Electronics Engineers

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tioner" which is used to modify critical inertial system output signals to make them suitable for telemetering back to earth.

The Librascope computer is a serial binary general-purpose machine that uses a magnetic drum for storage. The computer can perform the familiar arithmetic functions as well as logical commands, information pick-up and storage and input-output.

In addition to the main computer, the system includes input-output equipment for analog-digital conversion and a control unit which keeps track of time during prolonged coasting periods to permit the computer to be turned off to conserve vehicle electric power. The computer, control unit and input-output unit weigh 57 lb.

The guidance program is entered into the magnetic drum from punched paper tapes prior to the mission. The magnetic drum provides for total storage of 2,560 words, each 25 bits long, in 40 tracks of 64 words each. Of this total, 2,368 words are permanent storage and 192 words are temporary (working) storage. For the Centaur application, one of the 64-word temporary storage tracks is used as an eight-word recirculation line to speed computation of guidance signals. This reduces total temporary storage to 136 words.

Information Capability

Information can be read into or out of the temporary storage during powered flight and can be read out of permanent storage during such periods, but cannot be entered into the permanent storage during flight.

The computer receives signals from the three platform accelerometers in the form of pulses, together with time pulses from an accurate crystal oscillator.

To obtain vehicle velocity, the computer need only count the incoming pulses. To compute vehicle displacement, the accelerometer pulse count is integrated as a function of time using the oscillator pulses.

Computer outputs include three signals for steering commands to the autopilot, one for each axis, and three signals used for torquing the three gyroscopes during initial platform alignment on the ground and to compensate for gyro drift during flight. The six output signals are in analog form after analog-to-digital conversion.

In addition, the computer also has discrete output signals for staging and initiation of ignition and thrust cutoff sequences.

To use essentially existing hardware for the Atlas-Centaur, Convair settled for something less than an ideal system but has devised plans for getting around some of these limitations, Farr said.

For example, to obtain maximum possible accuracy from proven gyros instead of trying to use new unproven gyros with higher inherent accuracy, the Atlas-Centaur system will be calibrated immediately prior to launch. After the system has been initially aligned, Convair plans to measure the gyro fixed restraint drift and the mass unbalance drift coefficients for mass shifts along the input axes, Farr maintained.

These measurements will then be used to program the computer to supply gyro torque currents during flight which are automatically varied as a function of measured acceleration to compensate for this drift. Also prior to launch, the accelerometer bias and scale factors will be determined to permit the computer to correct its in-flight velocity and position computations.

Because of the Librascope computer design, which incorporates only one accumulator in the arithmetic unit, and the procedure used for multiplication, the computer's maximum computation rate is only 237 multiplications per second.

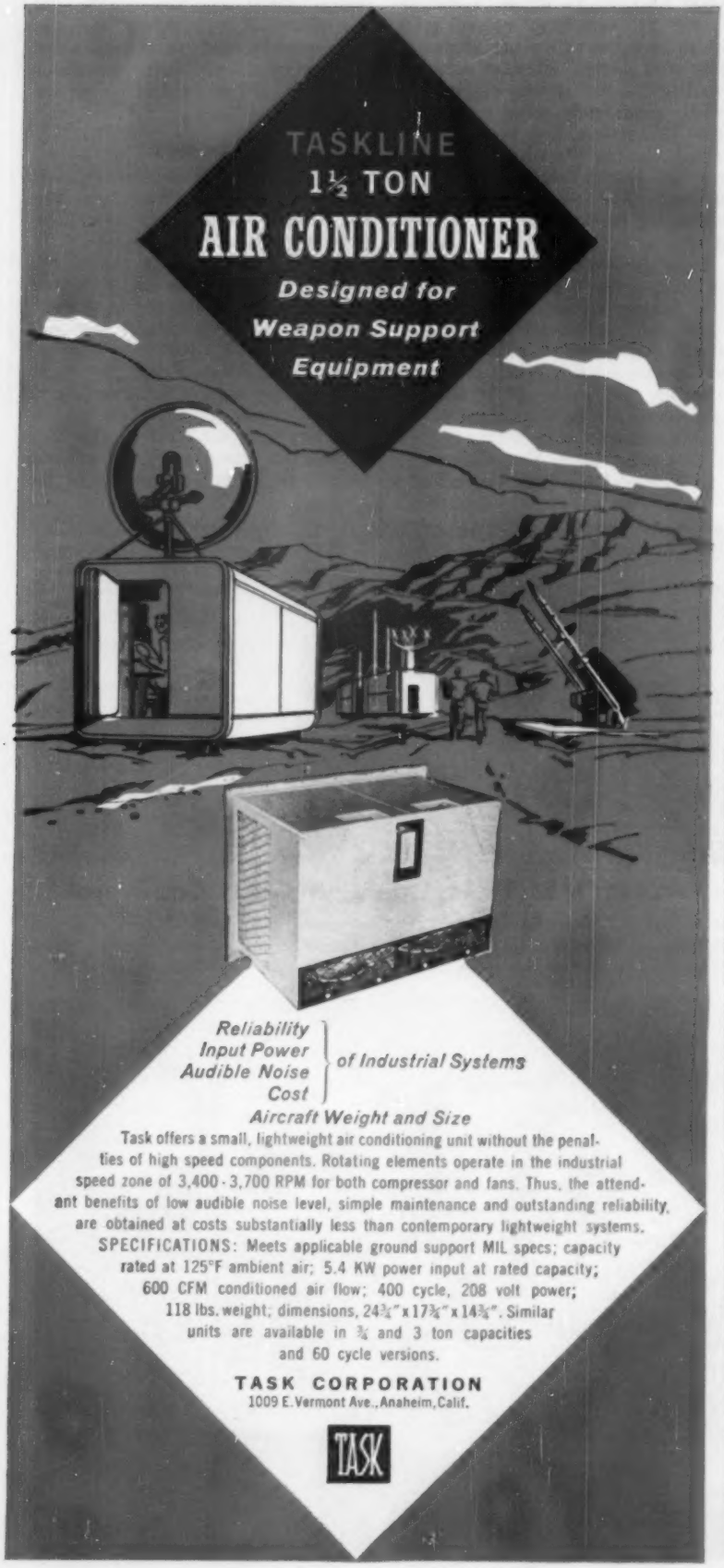
Speed-up Techniques

To get around this relatively slow computation speed, special techniques have been developed for the Atlas-Centaur application.

All computations that require fast iteration (adding) rates are performed outside the computer's arithmetic unit. These include the integration of vehicle acceleration, the double integration, the precise determination of engine cutoff commands and the generation of attitude steering signals. High iteration rates are required for the steering loop because the guidance system provides basic vehicle attitude signals to the

Azusa Mk. II Installed at Cape Canaveral

Azusa Mk. II missile tracking system has been installed by Convair Division of General Dynamics for USAF at Cape Canaveral, Fla. Radomes house precision antennas; control center is below. System supersedes Azusa Mk. 1 (AW Feb. 9, 1959, p. 65).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autopilot during Atlas sustainer and Centaur phases of powered flight to eliminate the weight of carrying separate gyros for the autopilot.

Because the platform uses integrating accelerometers whose output is in digital (pulse) form, it is only necessary for the computer to count these pulses to obtain vehicle velocity. The second integration to obtain vehicle displacement is performed in a track of the magnetic drum which serves as a recirculation line, called the "sigmator."

To achieve the precision required for engine cutoff, a high-speed countdown also is performed in the sigmator recirculation line. The cutoff parameter is calculated once every computation cycle, at approximately 0.65-sec. intervals.

When this parameter has fallen below a specified value, the last three computed values are used to calculate the estimated future time when its value will reach zero, and this predicted time-to-go is then stored in the sigmator line at a specified location.

At this location, the parameter value is then counted down in increments of 1.25 milliseconds until it reaches zero, at which time engine cutoff is commanded, Farr said. This same sigmator track on the magnetic drum also handles steering and gyro torquing outputs as well as the computer telemetry outputs.

Attitude Control

The high-speed vehicle attitude error loop is performed outside the computer itself.

The computer-generated "desired attitude" for guidance steering purposes is converted to analog form and transmitted to the stabilized platform resolver chain whose outputs represent the projections of these vectors on the roll, pitch and yaw axes of the vehicle. The difference between computed and actual attitude is transmitted to the autopilot as a steering command. The desired attitude for guidance purposes is computed at a rate of less than one iteration per second.

Because the present computer design does not permit continuous updating of stored guidance parameters to compensate for delays in scheduled launching time, it would be desirable to employ guidance equations whose parameters and form were completely independent of time. This is not completely possible, Farr said. However, it is possible to express only a small number of quantities in terms of launch time and then have the vehicle computer calculate the other guidance parameters from the launch-time dependent parameters. This is the procedure employed. ◆◆

USAF Orders Pilot Bio-Instrumentation

By Barry Miller

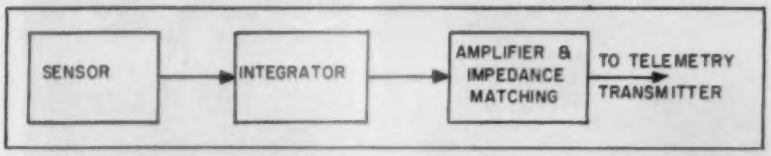
Los Angeles—An unusually short-duration study-to-hardware program in biological instrumentation was launched recently by the Air Force Flight Test Center at Edwards AFB. The bio-instrumentation program is expected to provide microminiature biological instruments during the next year for monitoring physiological responses of pilots during flights of forthcoming airborne and space vehicles.

While a spokesman for the center declined to name the vehicles for which the instruments are intended, the North American X-15 and then the Dyna-Soar boost glider are likely choices.

Four contracts now being awarded under the bio-instrumentation program call for delivery during 1961 of new sensors, microminiature signal conditioning packages and possibly tiny human-body-mounted telemetry transmitters as part of the signal conditioning units. When integrated with available sensors and government-furnished telemetry or airborne recording equipment, Air Force physicians will be able to keep vigil over pilots' reactions and life support factors under extreme environments of out-of-atmosphere and space flights.

The four contracts cover these instruments:

• **Linear pneumotachometers**—One prototype and six operational pneumotachometers are to be delivered by late April to the test center by Spacelabs, Inc., Van Nuys, Calif., under a 26-week, $23,579 contract awarded Oct. 31. This device measures the rate and depth, or volume, of human respiration.



LINEAR pneumotachometer being developed by Spacelabs, Inc., for Edwards AFB Flight Test Center will measure the rate and depth of a pilot's respiration during flights in airborne and space vehicles.

• **Universal signal conditioning packages**—One prototype and three operational devices capable of receiving a minimum of 12 transducer inputs and processing these low level signals into forms suitable for delivery to airborne magnetic tape recorders or telemetry gear for RF transmission to ground stations are to be designed and developed within the flight test division of Hughes Aircraft Co. The company received a $78,698 10-month contract for this equipment a few weeks ago.

• **Pressure gas sensors**—Awarded of a $47,100 contract for these sensors, which measure oxygen and carbon dioxide in a vehicle's cabin or in the pilot's helmet, is expected momentarily.

• **Blood Pressure Measuring Device**—Proposals for this item which will provide a measure of the pilot's blood pressure are deadlined for receipt at the flight test center no later than Jan. 3, 1961.

In-House Work

Award of these contracts follows an in-house effort in bio-instrumentation at the test center.

In addition to the equipment to be procured as part of the bio-instrumentation program, a data display console separately obtained by the center for other purposes, may be employed for real time readout of physiological and life support data at a ground station. Hence, physicians would be able to monitor vital human parameters and their inter-relationships from a ground command post during the vehicle's flight.

Delivered equipment is scheduled to be evaluated in a Convair TF-102 at Edwards.

Typical parameters to be monitored and characteristics of transducers available for these functions are indicated in an accompanying chart. These include:

• **Electrocardiogram (EKG)**—A measure of the electrical waveforms which reflect the heart's activity. Four inputs to the signal conditioning package probably will be reserved for EKG.

• **Galvanic skin response**—A measure of the change of skin resistance under mental stress. One input is set aside for this.

• **Skin temperature**—Skin temperature is to be measured by high-sensitivity thermistors probably located at four different points on the pilot's body.

• **Respiration**—Respiration readings may be supplied by an available pneumotachometer manufactured by Veco Mfg. Co. or, more likely, by the new devices being developed expressly for this project by Spacelabs.

• **Cockpit-to-suit pressure** and helmet-to-suit differential pressures. Unbonded strain gage transducers which weigh 8 grams and measure less than an inch in diameter, manufactured by Consolidated Electro-Dynamics Corp., Pasadena, Calif., may be used for these measurements. Different series of this line can measure ±5 psi. differential or ±½ psi. differential.

Final equipment is to be so designed that the pilot cannot suffer electrical shock and is not to degrade sensor input data by more than 1%. The design is to emphasize the following criteria in descending order of importance: reliability, diminutive size, long life and accuracy.

Study and development of the linear pneumotachometers is progressing in a similar manner at Spacelabs, according to Dr. George Sullivan, the company's medical director, who is a physician and an electrical engineer. Spacelabs is a young firm, slightly over a year in age,

PARAMETER	SENSOR	TYPICAL SOURCE	FREQUENCY RESPONSE	NUMBER OF DATA CHANNELS
Electrocardiogram	Grid Screen Sensors		d.c. to 60 cps.	4
Galvanic Skin Response	Galvanic Skin Response Sensor		d.c. to 100 cps.	1
Cockpit-to-Suit Pressure	Differential Pressure Transducer ± ½ psid. 350 ohms	Consolidated Electro-Dynamics Corp., Type 84683	d.c. to 2 cps.	1
Helmet-to-Suit Differential	Differential Pressure Transducer ± ½ psid. 350 ohms	Consolidated Electro-Dynamics Corp., Type 81559	d.c. to 5 cps.	1
Respiration	Pneumotachometer (thermistor) 5,000 ohms at 25C	Veco Mfg. Co. Type 35A5	d.c. to 5 cps.	1
Skin Temperature	Thermistor 2,000 ohms at 80F	Yellow Springs Instrument Co. Type 409	d.c.	4

BIO-INSTRUMENTATION signal conditioning packages to be developed by Hughes Aircraft Co. are required to accept a minimum of 12 physiological and life science data inputs of type indicated in this chart. Manufacturers of typical possible sensors and their characteristics are shown.

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whose prime purpose is to design and develop bio-medical instrumentation.

The linear pneumotachometer will sense the near sinusoidal respiration flow and provide a means of measuring the volume of oxygen a pilot in a space suit is receiving. Spacelabs' approach is to measure oxygen piped into the pilot's helmet, integrating this with respect to time, counting the inhalations, and feeding this data to a telemetry system. The device will consist, essentially, of a suitable sensor, and integrator and amplifying and impedance matching devices. Volume and rate expressed as height and width of a pulse would be transmitted every 5 sec. (1½ respirations) by a nominally 250 millisec. pulse.

Respiration Measurement

Normally, Dr. Sullivan explains, there are three techniques for measuring respiration. These are:

- **Flow measurement.** Placing a tube directly into the subject's mouth.
- **Body expansion method.** Covering subject's chest and measuring the amount of chest expansion which is a function of desired parameters.
- **Direct volume.** Measuring inhalation and exhalation from bags.

Spacelabs effort also divides into three phases. These are:

- **Phase I.** Aerodynamic study of flow and selection of a suitable sensor. This portion of the company's work is near completion. Three sensors are being considered. One is a form of anemometer in which oxygen flow varies resistance in one arm of a bridge circuit, thereby providing a functional indication of flow rate. A second is a Thomas meter in which a heating element sandwiched between two sensing elements is placed within and normal to the gas flow. Resulting elevated temperature of one sensing element is proportional to flow. The third is a porous plug type in which pressure drop across a filter inserted into the flow is proportional to the flow.
- **Phase II.** Spacelabs will build a prototype consisting of the sensing device selected at the end of Phase I and signal conditioning equipment which integrates the signal from the sensor, then amplifies it and delivers a zero to 5 v. output suitable for telemetry. Output is in ventilation rate, defined as the product of the rate of respiration and volume.
- **Phase III.** Six operating devices will be manufactured and delivered.

Dr. Sullivan says the probable size of the complete device will not exceed 1½ cu. in., or weigh more than 1½ oz. It is not expected to require more than 50 milliwatts of power.

Besides the Edwards program, Spacelabs is developing a number of biomedical instruments. Early last sum-

mer, Dr. Sullivan surgically inserted biologically implanted telemetry systems, developed under a North American Aviation subcontract (AW Oct. 3, p. 23) into the chests of two rhesus monkeys. He and his colleagues now are able to obtain respiration data, phonocardiograms and electrocardiograms by transmission from the transmitters inside the monkeys who apparently have not suffered any ill effects.

Such a device, he points out, offers the possibility of a constant self-monitoring of patients with coronary disorders. It could help pinpoint exact stimuli which cause heart trouble.

Input Package

Hughes reportedly was selected from among nine bidders for the signal conditioning hardware. It hopes to develop in the next 10 months a universal type of package capable of processing any transducer inputs, according to Lloyd McClellan, manager of the Flight Test Engineering Department of the Flight Test Division at Hughes. Exact nature of the devices is not yet determined, but the test center requires that Hughes determine the feasibility and seek means of:

- **Eliminating the need** for wiring transducer or conditioning equipment outputs through the umbilical cord of a full pressure suit. This is desired to ease restrictions on the pilot's movement imposed by a nest of wires and also to reduce risk of leaks in the suit's pressure seals. Such an approach would impose a knotty requirement of transmitting through the shielded suit.
- **Using the latest molecular** electronic or microminiaturization techniques in optimizing the final package design and configuration. The package is not to exceed 5 cu. in., including power supplies.

The equipment will be required to operate under the following working environments:

- **Pressure**—One to ½ atmosphere (approximately).
- **Temperature**—From 10F to 140F.
- **Humidity, impact accelerations,** linear accelerations—within the limits of human tolerance.
- **Full pressure suit**—David Clark, Inc., MC-2 or AP-22S.

Program Steps

Hughes' 10-month leg of the program will proceed in three steps:

- **Phase I**—For approximately 3½ months, Hughes engineers will conduct a design study to investigate all possible ways of handling the task. They will explore various techniques for making packages as well as various package shapes. They will seek means for attaching the package and possibly transducers to the pilot's body. These might range from a kind of mustard plaster attachment, or gluing to the body, to vest mounting. Shapes of package may be determined by the microminiaturization technique selected. If the umbilical cord is bypassed, the processing equipment will probably include tiny transmitters for relaying signals to a remote receiver in the vehicle's cabin from which they are re-transmitted to earth or recorded. Otherwise, 0 to 5 v. output signals processed for conventional data modulation techniques would be made available.
- **Phase II**—The company will build a prototype incorporating the concepts selected by the test center from the report at the conclusion of Phase I.
- **Phase III**—Three separate multichannel (minimum of 12 data inputs) signal conditioning systems, incorporating approved changes resulting from Phase II testing, will be delivered to the flight test center.

Optical Masers Made With Calcium Fluoride

New York—Optical masers, using calcium fluoride crystals which emit light in the infrared and visible red spectrum but which require considerably less pumping power than ruby masers previously reported, were described here recently by International Business Machines (IBM) Corp.

Using calcium fluoride crystals—a standard optical material—in which one-tenth of 1% of the calcium ions have been replaced either by trivalent (lacking three of the normal number of electrons) uranium or divalent (lacking two) samarium, IBM pumps the ions to higher energy levels with a xenon flash lamp. The lamp, emitting a very narrow beam of broad-band white light, mostly in the blue-green spectrum, is placed about eight inches from the crystal and trained on the center of the crystal through a small quartz lens.

Emissions from both uranium and samarium-type masers are coherent. IBM scientists predicted that, with improved dielectric ends on the crystals, the new materials will be able to provide continuous radiation. Optical masers using ruby crystals have so far been able to produce only pulsed radiation.

These new masers exhibit four energy levels, compared with three found in ruby. The fourth (terminal) is located between the lowest (ground) energy level and the intermediate (metastable) energy level.

As described in Bell Telephone Laboratories work on ruby masers (AW Oct. 24, p. 75), the ions are at rest prior to excitement by an external light source. Under pumping action from the lamp, the ions are raised to an unstable peak energy level. At this peak, the ions interact with the ions of the host crystal, give up some energy and drop to a less unstable, or metastable, -energy level. The drop is rapid and no radiation occurs between these two levels.

In ruby masers, the ions then fall from the metastable level to the ground level, emitting light in the process. But with uranium and samarium, IBM said, the ions drop to the terminal level (this band rapidly absorbs ions from the level above it and rapidly drops them to the level below it, thus remaining always relatively unpopulated compared with the ground level), and it is between these two levels that stimulated emission occurs in uranium and samarium-type masers. No radiation is emitted in the last fall from the terminal to the ground level.

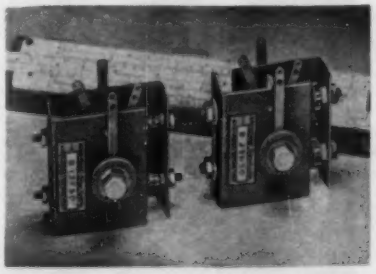
Because of this characteristic, IBM said, these new materials require from 500 to 1,000 times less pumping power than do ruby units to raise ions to higher energy levels.

Uranium absorbs energy from the xenon lamp at 5,500 angstroms, or in the green band, giving the crystal a red color. It emits infrared radiation at a wavelength of 2.5 microns. Samarium absorbs at 6,300 angstroms, or red band, making the crystal green. It emits at red light .708 microns.

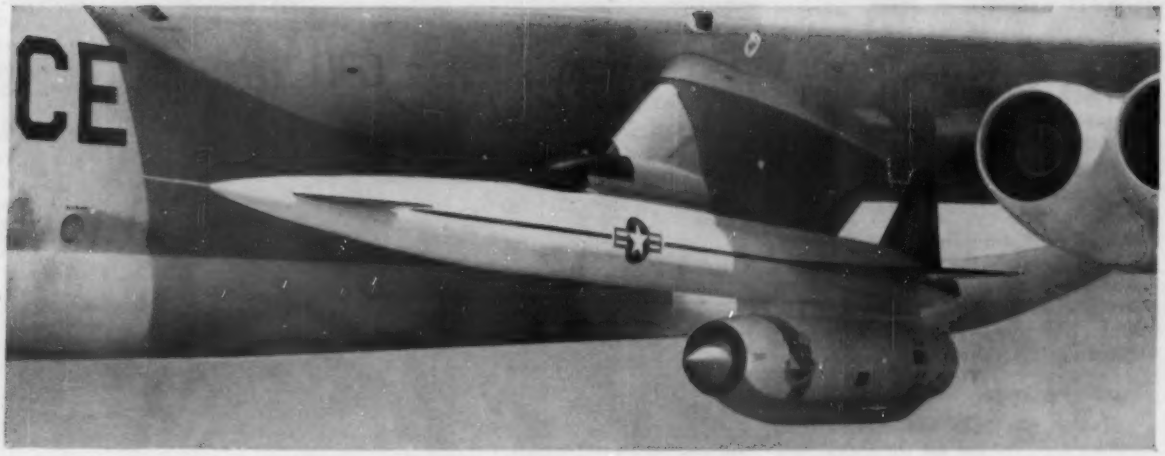
NEW AVIONIC PRODUCTS

- **Panel indicator light,** Model 855S-DS, mounts in ½ in. diameter hole and is shrouded so that light is not emitted from its sides. Bi-color version is colored when lit, white unlit. Color-Lite Division, Sloan Co., 7704 San Fernando Rd., Sun Valley, Calif.

- **Rectifier stacks,** mounted in dual-fin heat sinks and measuring 3 x 3¼ in. over-all are available in 5 to 50 amp. current ratings and with peak reverse voltage ratings of 50 to 500 v. Silicon diodes in the single phase bridge stacks



are 6 and 12 amp. diffused junction cells. Additional data contained in Bulletin SR-331 is available on request. Prices range from approximately $12 to $80 each in quantities from 1 to 99. International Rectifier Corp., 1521 E. Grand Ave., El Segundo, Calif.



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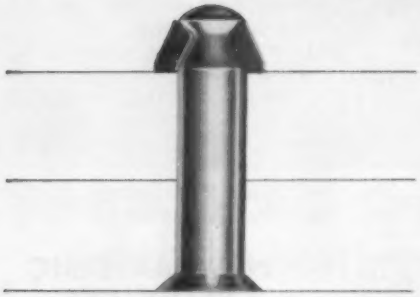
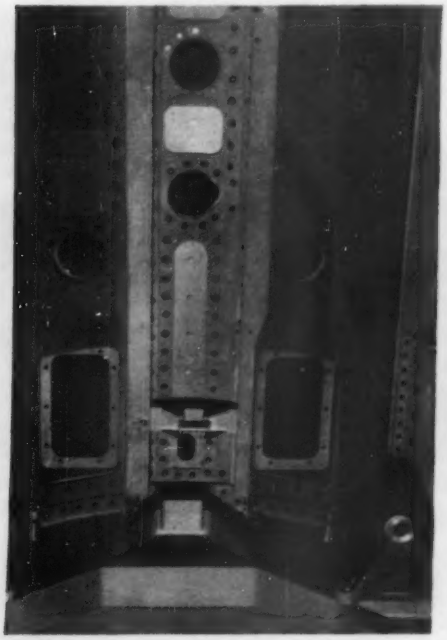


Stainless Steel Hi-Shear rivets, used throughout the Hound Dog in shear applications, meet 125,000 psi minimum shear and 220,000 psi tensile range requirements. Combined with R-Monel collars, these Hi-Shears can be used to temperatures up to 800°F.

Hi-Shears fasten structural fittings in the Guidance Compartment Doors (right) and primary structure in the Auto-Navigator area (below).



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In the Hound Dog and its pylon, Hi-Shear rivets are widely used throughout the entire stucture. Additionally in each B-52, tens of thousands of titanium Hi-Shears are used in primary structure... these light weight fasteners literally save hundreds of pounds of structural weight ...resulting in more range and greater payloads.

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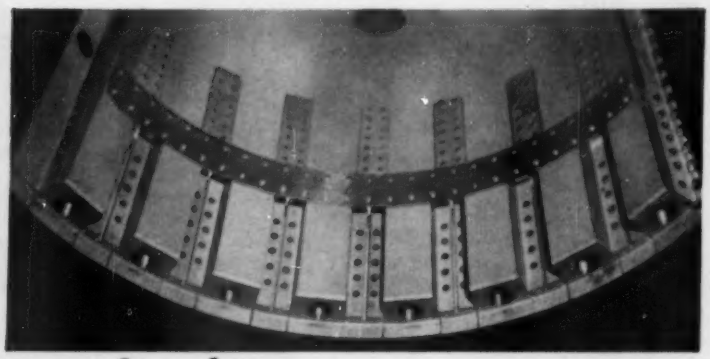
"HI-SHEAR" TRADEMARK REGISTERED U. S. PAT. OFFICE. U. S. PATENTS 2,355,873; 2,355,880; D-158-870; OTHER U. S. AND FOREIGN PATENTS PENDING.



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Simulator to Aid Spacecraft Ground-Test

By Edward H. Kolcum

Philadelphia—Simulator designed to improve spacecraft reliability through realistic ground testing in an integrated space environment is under construction here by General Electric's Missile and Space Vehicle Department.

The GE simulator will have a vacuum chamber large enough to accommodate full size spacecraft, and it will have what is expected to be the only collimated sun source in existence when it goes into operation in March, 1962. Project Advent communications satellite will be one of the first space vehicles to be tested in the facility.

GE established final design and systems performance requirements for the advanced space simulator last month. Building to house the $6 million facility is under construction at MSVD's Valley Forge Research Laboratory.

The facility will have an ultra-high vacuum cell duplicating extreme space vacuum; cold and highly absorptive chamber walls to provide cold black thermal conditions of space, and a sophisticated sun source provided by energy from an array of 7 kw. mercury arc lamps reflected to the test specimen in parallel rays by an off-axis segmented mirror.

Benefits From Simulator

With the environmental simulator, GE foresees the ability to:

- **Resolve thermal balance** problems and be able to design lighter and more advanced spacecraft.
- **Assess spacecraft** and systems performance, permitting development of components without the expense of actual flights.
- **Design the most efficient** thermionic and photovoltaic solar power systems.

Frank E. Stehlik, research laboratory manager, and Lou Michelson, who supervises construction of the simulator, told AVIATION WEEK the environmental chamber is being designed with growth potential and eventually may simulate effects on spacecraft of explosive decompression, ozone, staging shock, vibration, gamma and X-ray radiation, meteoric dust and planetary atmosphere gases.

The cylindrical vacuum cell, 32 ft. in diameter and 54-ft. high, will be built of ⅜ in. stainless steel. Size is considered adequate for full scale manned and unmanned flight payloads now foreseen. Chamber will accommodate a test specimen with a maximum single dimension of 30 ft., large enough for most vehicles planned through 1966.

Among advanced vehicles considered in setting final simulator configuration, size and design were 15-ft. solar paddles, manned life boats, recovery craft, maneuverable spacecraft, soft and hard lunar impactors, Advent communications satellite, Agena engine and manned space suit systems.

Largest vehicle considered for the simulator was the manned Dyna-Soar, which is estimated to have a maximum single dimension of 20 ft.

Design Problem

Michelson said the most difficult problem in vehicle design is determining the thermal balance of a spacecraft. Analytical solution of the problem would take several man years, he said, while the simulator can perform the same task in a single run, by direct measurements.

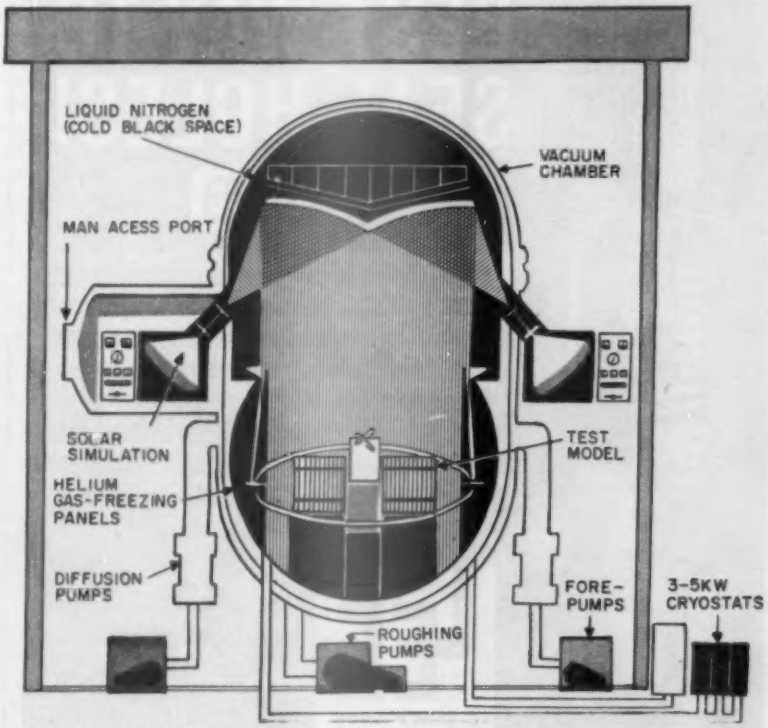
The heat problem arises because a space vehicle exchanges energy with its surroundings by radiation in low pressure. In space, energy sources are the sun and the earth. Earth emits infrared radiation, and the albedo, or reflected solar radiation. Albedo from other planets is considered an insignificant factor in energy transfer considerations.

This thermal condition is difficult to simulate in ground facilities because of temperature, reflectivity and incomplete absorptivity of chamber walls. General Electric's method of reducing simulator error is to cool highly absorptive wall panels with liquid nitrogen at a temperature of −382F.

Inner chamber is covered with a pattern of black aluminum panels through which cold nitrogen is pumped. Vehicle outgassing effect is controlled with a second set of panels, to which radiated molecules will attach themselves and be exhausted by diffusion pumps. Liquid helium is the working fluid in this cryogenic pumping operation, which will freeze out most residual gases.

Vacuum system has been designed to meet two requirements:

- **Ability to maintain** a pressure of 10^{-6} mm. of mercury under heavy loads, with maximum pressure of 10^{-4} mm. of mercury.
- **Ability to outgas** radiated molecules



SPACE environment simulator will facilitate ground-testing of full-size space vehicles. General Electric $6-million Valley Forge (Pa.) facility will be operational in March, 1962.

Simulator Availability

Philadelphia—General Electric projects will have first call on the Valley Forge space simulator, but competitors and the government will be able to use the facility on a time available basis. GE estimates the facility will rent for $700-$1,000 an hour.

from the test specimen so they cannot rebound from chamber walls and impinge on the test specimen.

Pump Systems

The test cell will be equipped with four systems of pumps. Pressure of 10^{-6} mm. of mercury will be obtained with mechanical roughing pumps. Oil vapor diffusion pumps will be used to remove non-condensable gases. Effect of cold black space will be obtained with liquid nitrogen pumped through panels, and high speed cryostats will pump the helium gas-freezing system.

Normal pump-down will take about 4 hr., but the facility will be able to duplicate the same pressure reduction a spacecraft experiences on launch by programing a high-speed operation with the same time sequence as a flight profile.

Most novel feature of the environmental chamber is the solar subsystem, which, combined with the black space nature of the test cell and pumping capability, is expected to provide an accurate measure of thermal balance.

General Electric's solar system is the first which will provide parallel rays of the same brightness and intensity as the sun uniformly over the area of the test specimen. Distributed lighting sun sources are in use, but GE said distributed lamps give overlapping beam patterns, with uneven distribution of luminosity.

Requirement for spectral distribution similar to the sun resulted in development by GE's Large Lamp Department of a 7 kw. high energy xenon-mercury lamp which emits ultraviolet light. Brightness of the sun could be simulated with carbon arcs, but the spectrum is different, and the short lifetime of the carbon arc makes this source unattractive. GE hopes its new 7 kw. lamp will have a 1,000-1,500 hr. lifetime.

Mercury Lamp Arrangement

Four banks of high-power mercury arcs will be placed equidistant around the vacuum chamber and will be focused on four parabolic mirror sections, which have the characteristic of reflecting a collimated, or parallel beam. Panel arrangement and absorptivity prevents reflection of light back to the mirrors.

The beam is designed to produce the same effects as the sun—an energy of 130 watts/sq. ft. Combined energy from earth's albedo and its infrared radiation, 65 watts/sq. ft., will be simulated by other lamps when the spacecraft is affected by this energy.

In addition to determining thermal balance of a spacecraft, the sun system will be used to assess a variety of solar collectors. Company plans to check solar cell coatings as well as efficiency of direct-conversion thermionic cells and two-stage photovoltaic cells. Latter system uses a metal such as germanium, which releases photoelectricity when it is heated.

Preliminary plans have been made by GE to attempt simulation of all but two of the other known environmental characteristics of space. Duplication of the effects of high nuclear and cosmic radiation, estimated at 20 billion electron volts, is not being considered. No

Lockheed Simulator

Sunnyvale, Calif.—High vacuum orbital simulators (HIVOS) facility is scheduled to begin operation at Lockheed's Missiles and Space Division here in August to simulate long orbital missions for satellites and spacecraft.

Although the test equipment will be used for various programs, it was designed primarily to test Lockheed's Agena rocket stages. Operation of the chamber will be automatically programed and controlled, using a low-speed digital data acquisition system for recording and monitoring functions (AW Nov. 14, p. 23).

Housed in a 90-ft. high structure, the chamber will have an inside diameter of 18 ft. and height of 20 ft., and it will accommodate a satellite 8 ft. in diameter and 15 ft. long. Provision for expanding the chamber to 35 ft. height will give it potential to handle test specimens 10 ft. in diameter and 32 ft. long.

Panels of quartz lamps will provide solar heat simulation of up to 1,000 Btu./sq. ft./hr. Chamber walls will be cooled with liquid nitrogen to attain —320F.

To obtain a vacuum approximating conditions at 200 mi. altitude, Lockheed will use 22 diffusion pumps with 32 in. diameter, plus eight roughing and ejection pumps. Vacuum pressure design limit will be 10^{-6} mm. of mercury, with potential for an even lower evacuation.

Estimated cost of the facility will be $3.5 million. Consolidated Vacuum Corp., Rochester, N. Y., will build the $1.6 million chamber, and the Puget Sound Bridge and Dry Dock Co. will produce structural components. Tenney Engineering Co. will furnish heating units.

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method has been devised to duplicate zero gravity over extended periods.

Conditions which will be incorporated in the simulator in future instrumentation phases include:

• **Ozone,** which is highly corrosive, and is found in a free state in the upper atmosphere. Long-term effects of ozone on spacecraft are largely unknown. Ozone will be generated by using an infrared filter on the ultraviolet light source.

• **Shock,** from staging and orbital transfer mating. Test vehicle will be impacted at forces ranging up to 35g to simulate staging, and to 2-5g to simulate rendezvous docking.

• **Explosive decompression** to be accomplished by blowing a hole in a spacecraft in an ultra-high vacuum.

• **Vibration,** in which the test vehicle will be sting-mounted and subjected to low frequency, high amplitude motion.

Social Impact Studies Suggested to NASA

Washington—Brookings Institution has proposed 30 high-priority research projects as the beginning of a long-range program aimed at determining the likely social impact of peaceful space activities.

Report on the year-long Brookings study is the third completed in a program funded by the National Aeronautics and Space Administration through its committee on long-range studies (AW Nov. 21, p. 28) on the socio-economic implications of space research and exploitation.

If Brookings' suggestions are followed NASA would set up a core of senior social scientists who would develop support for sociological studies, identify and assign priority to problems, manage in-house and contracted research and apply the findings.

Principal author of the Brookings report is Donald M. Michael. The study began last December and was funded under a $96,000 contract. The institution said the full range of potential studies was so great that a choice was made to develop a program which would most effectively contribute to NASA's statutory responsibility, which includes the study of socially beneficial areas in space research. As a result, Brookings recommended research efforts to determine the impact of space research on:

• **Industry,** by studying the apportionment of NASA business to space firms, examining the history of technical change and the way corporations adjust to change and studying economic and political objectives of regulating space activities.

• **Government operations,** including means of retaining a highly trained staff in NASA interagency cooperation, career motivation and relationships between the President's science adviser and the NASA administrator and the respective groups that work with them.

• **Communications satellite** design, by determining demand for increased capability; means of serving private enterprise, the nation and special interest groups; appropriate division of roles and responsibilities; arrangements for international negotiations for use of the system; international control, and types of learning possible with satellite telecommunications.

• **Weather satellite forecasting,** by determining the makeup and development of a world-wide weather organization, possible weather control, effect on farmers and farm policy, effect on tourism and recreation, and national and international support.

• **Technical byproducts** of space research, such as power sources, structural materials and reliable electronics components. Watchdog groups are considered necessary to identify new products with non-space applications, cost-consumption relationships and automation effects.

• **Foreign relations,** by determining size and nature of sharable programs; studying the novel, complementary or competing programs of international groups; identifying the differences between U.S. and Soviet systems and cultures, and studying the influence of space activities on decision-making in foreign countries.

• **Attitudes and values** changed or reinforced by space activities, which involves a study of ways to assign priorities between competing scientific and social efforts; determining public state of the knowledge of on-going and projected programs; examining public knowledge, expectations and attitudes toward Project Mercury and the pilots; determining the effects of discovery of life on other planets, and determining historical factors which have influenced support or rejection of new ideas and technologies.

UN Action Expected On Space Conference

Washington—International interest in the United Nations Space Conference has been revived, and the UN Secretary General is expected to ask the Outer Space Committee soon to negotiate a time, place and agenda.

If a decision is made to hold the conference in 1961, attempts will be made by some U.S. members of the International Astronautical Federation to have the UN meeting held in Washington and to combine it with the 12th annual IAF congress.

The IAF congress originally was scheduled for New York City late next fall, near the time of the host American Rocket Society's annual meeting, but it now has been shifted here. The attempts to combine the two would be aimed at ensuring that neither overshadows the other, and at getting a larger attendance for both.

The official U.S. viewpoint may not favor a combined meeting, since the UN conference is looked upon as the first opportunity to exchange technical information on an official basis—a necessary requisite to negotiated cooperative space programs—and IAF is not an official body.

The U.S. has maintained that technical and legal agreements cannot be based on either unofficial international meetings such as the IAF congress, or meetings of quasi-official bodies such as the Committee for Space Research (COSPAR).

Strained U.S.-Soviet relations have prevented development of detailed plans for a UN space conference, even though a General Assembly resolution passed a year ago called for a conference in 1960 or 1961.

Now, however, there are indications that at least 21 nations want to participate in such a conference. They include the U. S. and the USSR, and Albania, Argentina, Australia, Austria, Belgium, Brazil, Bulgaria, Canada, Czechoslovakia, France, Great Britain, Italy, Japan, Mexico, Iran, India, United Arab Republic, Poland, Sweden, and Ukrainia.

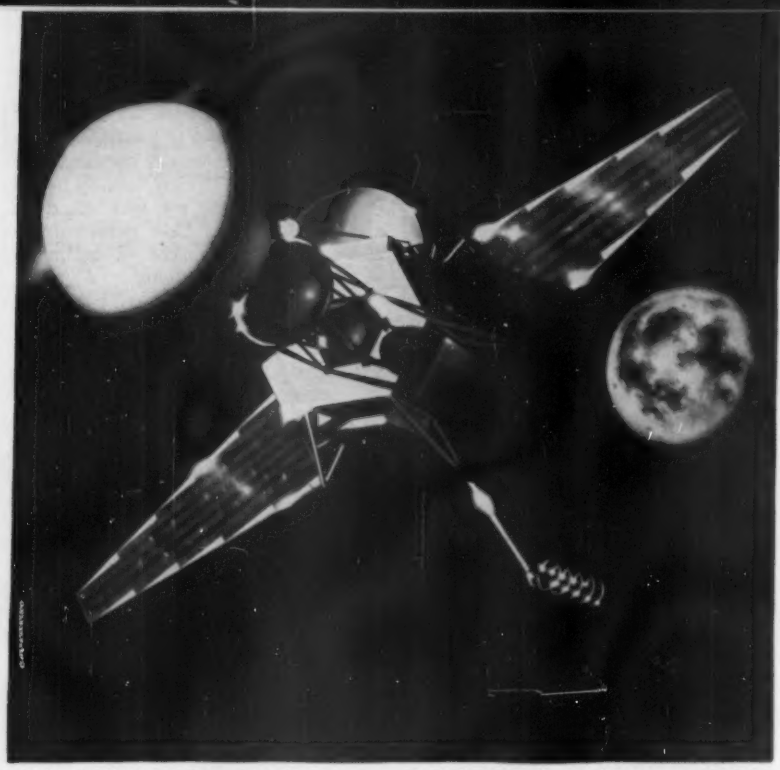
New Tracking Ships Scheduled for AMR

Cape Canaveral—Defense Department will spend $51.6 million to convert two C-4 cargo ships into floating tracking stations to augment Atlantic Missile Range capability.

Conversion of the 11,000-ton World War II ships is the major element in a $62.9 million range modernization program approved earlier this month. Other improvements will include advanced telemetry, optical, timing, data distribution and processing equipment, to cost $9 million, plus improved range communications nets, to cost $2.1 million, and continued precision geodetic surveys, costing $150,000.

The C-4 vessels will carry radar, communications, telemetry and infrared instrumentation and will provide a flexible means of extending the island chain. The ships are 520-ft. long and will carry 104 persons, including 54 missile instrumentation technicians.

Advanced equipment for the land stations will be used for development of Minuteman, Centaur and Saturn programs. Installation of the new instrumentation will begin immediately.



FINAL CONFIGURATION of 300-lb. lunar capsule being built by Ford Motor Co.'s Aeronutronic Division for NASA is shown in artist's rendering above. The lunar capsule and its retrorocket are shown attached to the Ranger spacecraft which will carry it to the vicinity of the moon. Capsule separation from spacecraft will be triggered by altimeter about 20-25 mi. from the moon (AW Oct. 24, p. 31).

Aeronutronic Tests Ranger Lunar Capsule

Newport Beach, Calif.—Instrument capsule for Ranger lunar vehicle, being developed by National Aeronautics and Space Administration, is being subjected to laboratory environmental tests here by Ford Motor Co. Aeronutronic Systems Division.

The 300-lb. spherical capsule has been exposed to temperatures as low as −320F and will be tested at high temperatures later. Temperatures on the moon range from −250F during the lunar night to 250F in the lunar day. A lunar night is equal in length to 17 earth days.

Electronic equipment in the capsule is intended to operate at 75F. Solar power system is expected to generate enough heat to offset radiation losses.

Tests are being carried out in Aeronutronic's vacuum test chamber. A circulating liquid nitrogen cold trap was installed in the chamber for the tests and the capsule was placed in the trap.

The lunar capsule will carry a seismometer to detect moonquakes as well as other instruments. It will transmit for a month or more. The capsule will be transported to the moon by the Ranger spacecraft now being designed by California Institute of Technology's Jet Propulsion Laboratory and an Atlas-Agena B launch system (AW May 16, p. 69). The spacecraft will transmit close-up photos until the capsule separates and will measure radioactivity till it is destroyed by impact.

Hawaiian Site Bid As Next Launch Facility

Washington—Hawaii is making a strong bid to have the next space vehicle launching facility located in its island chain and has sponsored a study which concludes that the Mauna Kea summit meets all criteria required of a polar and equatorial launch site.

Located on the sparsely-populated island of Hawaii, Mauna Kea is reported to have favorable launching weather 95% of the time with substantial low-cost land available for space operations.

Area capability study for the state planning office was made by an engineering and construction team of Parsons-Law and Wilson. Report on the study indicates that the Mauna Kea extinct volcano site could provide:

- **Maximum travel over water** to eliminate international problems. Polar launching trajectories would be entirely over water.
- **Best opportunity** for equatorial launches of any location in the U.S. At a north lattitude of 19.5 deg., Hawaii is nearer the equator than any of the other states, and the initial 4,500 mi. of an equatorial launching path would be over water.
- **High use of existing** and proposed tracking, control, communications and data acquisition facilities of the Pacific Missile Range.

Study proposes that a launch complex be located at the Mauna Kea summit, which is at an altitude of 13,784 ft. Proposed industrial support complex would be the southwest slope about 10 mi. from the summit, convenient to the main island city of Hilo.

Launch site suggested is a relatively flat area of several hundred acres with a solid rock foundation. Both launch and summit area are owned by the state and have assessed values ranging from $1-$5 per acre.

Electric power and water requirements for the complex can be met, and an adequate labor pool is available to construct the facilities, according to the report. Land lines and high density microwave communications facilities are available, with only 75 of the 240 microwave channels presently in use.

Facility would use the port of Hilo, 194 naut. mi. from Honolulu, and four airports as transportation facilities. The island chain is served by 10 airlines, which account for 75% of its passenger traffic, and eight steamship lines.

The main airport, General Lyman Field, has 5,600 ft. and 6,500 ft. runways, and the 6,500 ft. runway is being extended to 10,800 ft. to serve as an alternate for Honolulu International Airport.

The Kabanov Effect

Washington—Soviet Union has awarded top honors to its scientist Nikolai Kabanov for his "outstanding discovery" that high frequency radio waves back-scatter from the ionosphere as well as being reflected, according to Moscow News. The "Kabanov Effect," as the discovery henceforth will be known according to the Soviets, will enable radar to probe anywhere around the earth instead of being line-of-sight limited. The technique also will make it possible to select "the most advantageous frequencies for long-range radio communications," according to Moscow News.

The Soviets make no mention of the U. S. Navy's Project Tepee missile detection system, publicized 15 months ago, which employs ionospheric back scatter of HF radio waves. The Soviets also ignore Air Force experiments in high-frequency back-scatter radar, reported by Aviation Week more than seven years ago (AW Aug. 17, 1953, p. 327) out of which came the Communication Zone Indicator (COZI) for determining optimum HF frequencies for communications with any desired location.

Boeing Confident on Minuteman Profits

New York—Financial community speculation that Boeing Airplane Co. would retain as little as 15% of Minuteman funding, making the size of the USAF solid propellant intercontinental ballistic missile business for Boeing only a fraction of one of its previous jet bomber programs, appears to be overly pessimistic.

Current Boeing Minuteman contracts total more than $300 million. This is more than 15% of the total program, according to H. W. Haynes, Boeing vice president-finance, and this is just the initial phase of the over-all program.

Boeing's portion of the program as associate prime contractor could well approach the magnitude of a program as the B-47, Haynes told the New York Society or Security Analysts. Boeing's responsibility covers:

- **Development and production** of major components of ground support equipment and transportation equipment, test and instrument subsystems and missile interstage structure.
- **Test program** covering the entire missile, silo and launching system, instrumentation and firing.
- **Missile assembly** at Ogden, Utah, and assembly of the complete weapon system at launch sites.
- **Base design** and equipment installation, including a broad responsibility for coordination and surveillance to assure bases reaching operational status on schedule.

Optimism Contrasted

Haynes' relative optimism on Boeing's Minuteman share was in contrast to the caution of Boeing President William M. Allen before the analysts in December last year (AW Dec 28, 1954, p. 81). Allen said then that Minuteman would not approach the size of Boeing's B-47 program and that Boeing, to meet the changing pattern prevailing in weapon system contracting, would have to win more of the smaller contracts expected to maintain sales volume.

Haynes pointed out that the Minuteman program had been accelerated and Boeing's part in it had become firmer since Allen's appearance. The mobility program has entered the picture and the base development and design responsibilities of Boeing have been specified.

Status of other current programs at Boeing include:

- **B-52.** Current funding for the B-52G, phasing out, and the B-52H extends the program into 1962 and Boeing hopes improvements will extend production life.
- **Bomarc.** Current funding entends deliveries into the fall of 1962. Future possibilities are a mobile version or foreign sales.
- **KC-135.** Total orders to date cover 564 aircraft and the 72 airplanes provided for by Fiscal 1961 funds will extend deliveries into the fall of 1962.
- **Dyna-Soar.** Boeing has basic responsibility for design, manufacture and test of the glider portion as well as broad coordinating functions for the booster, launch complex, down range instrumentation, etc. Suborbital flight tests of an unmanned glider are to begin in three years, and manned suborbital flight is to follow. Present contracts are for research and development.

Division of Dyna-Soar responsibility sparked a question based on an appearance before the analysts a week before by William B. Bergen, president of the Martin Co. Bergen was quoted by the questioner as saying that, "Boeing has the glider and Martin has everything else." The cryptic reply from Allen, who accompanied Haynes: "It depends on your point of view."

Diversification and the future in general of the aerospace industry were touched on by Haynes, who noted that Boeing was diversifying broadly in its traditional fields of defense products and air transportation.

To illustrate, he provided a Boeing sales comparison:

	1957	1960
Military aircraft, spares	92%	38%
Missiles and space	8%	30%
Commercial aircraft, spares	–	32%

Boeing is looking at "non-traditional" fields for expansion, Haynes said, but feels its first moves ought to be in areas covered by current Boeing technical and administrative capabilities.

"There is a tendency," Haynes said, "to look at an aerospace company almost as if it were living on borrowed time—as if each production program were its last. We think this is unrealistic.

"The leaders of the aerospace industry are geared to provide a necessary and continuing service to the country. The military and commercial markets are, in total, large and growing. Of significance, of course, is the substantial increase in competition for these markets. Such factors are basic to our planning.

"Assuming the existence of a growing market, the basic strength of a company as a business enterprise does not lie in its backlog of contracts—or even in the number and types of proposals in the mill [and they are many]—but in the totality and quality of its resources—technical, manufacturing, administative, financial and managerial."

As to its commercial jet transport programs, Haynes said Boeing estimated a total world market for 1,800 airplanes and that Boeing's share of this market should sustain a commercial production program through the next decade (see chart).

Total Market

Military orders for jet transports were included as a possibility by Haynes. Boeing has submitted proposals for the Military Air Transport Service interim buy based on both the KC-135 and the 707. "In fact, "Haynes said, "the C-135 model which we have proposed would be an off-the-shelf aircraft, the price of which would be well below the prices of other jet aircraft entered in the competition."

Boeing's pre-tax loss on the 707-720 program on the basis of firm orders is slightly in excess of $150 million.

World Jet Transport Market

	Delivered or on Order		Estimated Additional Deliveries		
	Total, all manufacturers	Boeing	1961-65	1966-70	Total
Intercontinental	234	98	100	150	250
Medium-long range	363	159	250	375	625
Short-medium range	213	80	350	575	925
	810	337	700	1,100	1,800

(Boeing percentage: 41.5%)

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which, Haynes said, is substantially below the indicated loss at the end of 1959. Not only have new orders helped, but greatly improved cost trends developed this year.

Boeing actually reported a $152 million loss at the end of 1959 on the program (AW May 2, p. 177), but if no more orders had been received in 1960, inventory write-downs and write-offs might have carried the total pre-tax loss as high as $200 million in 1960.

Haynes estimated 1960 total sales at $1,575 million and earnings at $22-24 million or $2.75-$3.00 a share. Current programs could increase 1961 sales and push earnings to $4 a share, he added.

The latter figure takes into account negotiations under way with the services over sharing of certain allowable research and development expenses. Haynes said Boeing probably would wind up with a share at least as high as Grumman's 50% (AW Nov. 7, p. 28) and that it might well be somewhat higher.

Navy Delineates Tough Procurement Policies

New York—Navy is following up its drive (AW Oct. 24, p. 28) for better weapons at lower costs and delineating its tougher procurement policies in more detail. Planned steps include the following:

- **More precisely worded** production timetable clauses in contracts, with scaled penalties for failure to deliver on time.
- **Fixed-price contracts** for secondary production, when first-run production has clearly identified weapon costs.
- **Preference to initially** accept fixed-price bids over cost plus fixed fee (with both bids meeting technical requirements) or at any point in a program's development, even for first-contract, research and development projects.
- **Further reductions** in government-provided facilities, general purpose tools and equipment.

Rear Adm. Paul D. Stroop, chief of the bureau of naval weapons (BuWeps), and Rear Adm. Joseph E. Dodson, assistant chief for fleet readiness within BuWeps, set forth the Navy's position at the American Ordnance Assn. meeting here on Dec. 7, in anticipation of a formalized BuWeps policy instruction to be published soon.

BuWeps policies, Adm. Stroop said, contain the best features of the former BuOrd (Bureau of Naval Ordnance) and BuAer (Bureau of Naval Aeronautics) procurement philosophies. For aircraft and most major missile systems, the old BuAer system of performance specification and design competition will be used in the selection of contractors. Since these large weapon systems involve heavy investments in facilities and tools and usually some proprietary design rights, Navy will continue sole source procurement with one contractor for the over-all system. Components, however, are expected to be broken out for competition or small business set-asides.

Adm. Dodson said that Navy would like to see contracts contain penalty clauses for slipped scheduled production dates similar to those penalties now being imposed for failure to meet performance and reliability specifications. Although Navy can reward improved performance, lower costs or higher reliability through incentive clauses in contracts, he said that there could be application of this feature for beating production deadlines because of expenditure ceilings and the meshing of production deliveries with deliveries of support equipment, training programs, build-up of spare parts, etc.

Further, Adm. Dodson said, Navy is getting out of the facility business. When BuOrd and BuAer merged, there were 44 Naval Industrial Reserve Aircraft and Ordnance Plants (NIRAPs and NIROPs); today there are 30 Naval Weapon Industrial Reserve Plants (NWIRPs); 45 government owned and operated plants have been cut down to 41 and more will be released as requirements permit.

Contractors who intend to continue in the defense business must be prepared to provide their own facilities and tools, Adm. Dodson warned, and—except in instances where production is limited, yet requires extensive investment in facilities and tools—not look to the government to provide the means of production.

Documentation required under contract will break out into two main areas, Adm. Stroop told the Ordnance meeting. For aircraft, where sole source procurement is the rule, documentation sufficient for operation, overhaul, repair and maintenance purposes will be sought. For smaller weapons, missiles and underwater ordnance items, complete and detailed documentation will be required so as to facilitate competitive secondary procurement.

Weapons Development Cost-Cutting Urged

Los Angeles—Rising development costs of military weapon systems are a serious threat to the nation's defense effort, John H. Rubel, Deputy Director of Defense Research and Engineering, warned a meeting here of the Institute of Radio Engineers.

The relative cost of weapon systems development compared with weapon system procurement has been increasing rapidly during the last several years

until it now equals half the cost of hardware procurement, Rubel said.

Within the last few months, the Defense Department has been confronted with requests for more than $500 million for several major missile programs beyond what originally was budgeted for them, Rubel said.

Increasing percentage of the Defense research and engineering budget, which now totals $6 billion a year, is going for fewer and fewer major programs. More than one third of this figure is being used to support five programs: Titan, Minuteman, the B-70, Nike Zeus and the Polaris fleet ballistic missile.

"It is important to utilize our available resources with prudence and wisdom," Rubel said. Many of the present upward cost trends must be altered, and in some instances reversed, if we are to maintain a wholesome balance in the choice of weapons developed for defense, he said. "This growth in costs limits our flexibility and heightens the importance of nearly every decision we try to make."

On the subject of Defense Department decisions on the relative merits of individual weapon system programs, Rubel said that it is important that the technical problems and project details required by Defense officials in making such decisions "be available in an objective, digestable and in a timely manner."

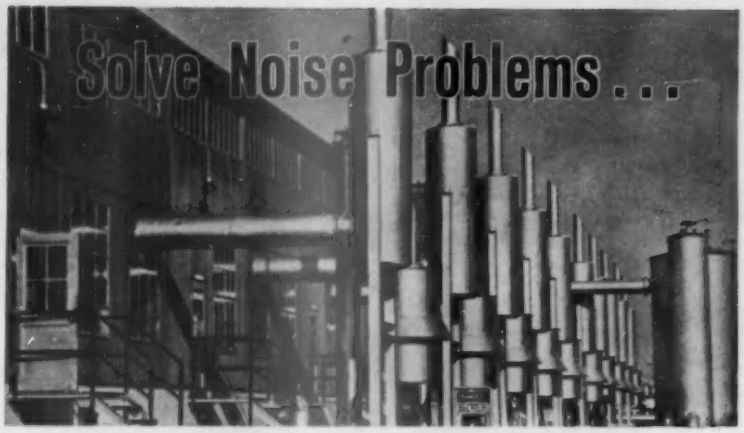
Because there is a practical limit on the number of qualified people and dollars available for defense, every "yes" decision by the Pentagon, authorizing continuation or expansion of one program, means that one or more "no" decisions must be made on other programs, Rubel pointed out.

The deputy director of defense research and engineering called on industry to help the military hold down embellishments which add relatively little to over-all weapon system effectiveness, but increase costs and delay program completion. Rubel also called for more candor and less "brochuremanship" in industry's proposals, briefings and reports to the Defense Department.

Aeroflot Claims Pilots Have Better Benefits

Moscow—Aeroflot, which pays its flying personnel less than many major Western carriers, claims that the lower cash income is more than balanced by the better working conditions of Soviet crew members.

Trade union officials who carry on propaganda work among Aeroflot personnel, contend that Soviet jet transports' large, five-man crews increase safety and that pilots get more time off



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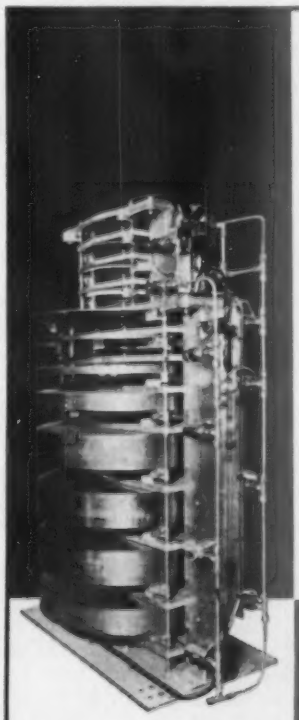

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than in capitalist countries. They say Aeroflot crew members "as a rule" receive 24 working days leave twice a year.

Average flight time for pilots of Aeroflot's piston-engine planes are 8 hr. daily and 120 hr. monthly, for turbojets 7 hr. daily and 60 hr. monthly, and for turboprops 6½ hr. daily and 70 hr. monthly. In addition, flying personnel are guaranteed at least 41 hr. of uninterrupted rest each week.

Record Earnings Forecast by Lear

New York—Lear, Inc., estimates it will earn a record $2,800,000 on sales of more than $90 million in 1960, according to Albert G. Handschumacher, corporation president.

Handschumacher told the New York Society of Security Analysts that the company also soon will produce microcircuitry for its own instruments from a new Solid State Physics Laboratory and will be able to supply it to other manufacturers next year.

Lear in 1959 had net earnings of $2,407,000 on sales of $87,002,000. As of last Sept. 30, the company had $210,000 in outstanding debentures. Present capital investment is $11.8 million and Lear expects to add another 100,000 sq. ft. of plant space this year and early 1961.

Mergers And Acquisitions

Bendix Corp. has purchased the Micrometrical Manufacturing Co., a firm that produces equipment for measuring the surface finish of metal, paper and plastic materials. Micrometrical's land and building in Ann Arbor, Mich., will be used by Bendix under a long-term lease and the company will continue under its present name and management as a subsidiary of Bendix.

Itek Corp., Waltham, Mass., has purchased from M. Steinhal and Co., parachute manufacturers, and CBS Laboratories, their joint venture company, Space Recovery Systems, Inc., of Los Angeles, Calif. Space Recovery Systems is currently working on crew escape capsules for the B-70 program and on the design and manufacture of parachute recovery systems for Army drone aircraft.

Electro-Science Investors, Inc., Dallas, Tex., has purchased over 80% equity in Knapic Electro-Physics, Inc., Palo Alto, Calif., for $2,000,000. The equity consists of convertible debentures and common stock. Knapic Electro-Physics produces 40% of the silicon and germanium crystals used in the U.S. for the manufacture of semiconductive devices such as transistors, rectifiers, diodes and solar cells.

Financial Briefs

Perkin-Elmer Corp., Norwalk, Conn., earned $138,710 on sales of $5.4 million for the first three months of its 1961 fiscal year ended Oct. 31. In the same period last year, company sales were $3.2 million and earnings were $55,550.

Aerospace Research Inc. is a new research and development firm with offices and laboratories in Cambridge, Mass. In addition to research and development, the company will conduct theoretical studies, field measurement programs and data reduction and analysis in the fields of radio propagation, communications, solid state instrumentation and ionospheric physics.

Electro-Tec Corp., South Hackensack, N. J., sales for the first half of Fiscal 1960 ended Oct. 31 were $2,844,000, a gain of 34% over the $2,120,000 reported in the same period a year ago. Net income was $117,000 on 592,500 shares outstanding versus $106,000 on 500,000 shares outstanding a year previous.

Cubic Corp., San Diego, Calif., expects to double its 1960 per-share earnings over 1959. Earnings at the three-quarter mark in 1960 rose to $238,190 from $144,022 in the same period last year. Sales for the first nine months of 1960 were up to $6,422,102 compared with $3,633,177 at the same time last year.

ITT had earnings of $21,137,268 for the first nine months of 1960. This compares with earnings of $18,670,120 for the first nine months of the previous year. Total sales and revenues by Sept. 30, 1960, were $580,058,955, an increase of $47,052,447 over nine month earnings for 1959. Sales and earnings for both years were restated to exclude the accounts of ITT's $35,000,000 investment in Cuban subsidiaries which were confiscated by the Cuban government.

Camloc Fastener Corp., Paramus, N. J., reports preliminary net income of $157,127 for the nine months ended Sept. 30. Earnings for the same period last year were $338,033. Sales in the initial nine months of 1960 were $2,748,970 as compared with $3,921,651 for that period last year.

Varian Associates, Palo Alto, Calif., recorded a 21% increase over last year's sales of $38,483,543, bringing this year's figure to $46,482,031. Earnings for the fiscal year ended Sept. 30 were $2,861,886 compared with the previous year's $2,580,340.

Rohr Aircraft Corp., Chula Vista, Calif., net earnings for the three months ended Oct. 31 amounted to $985,462, more than double the $442,675 for the same period last year. Sales for the quarter came to $33,177,098, compared with $50,095,658 for the quarter a year ago. Reinstatement of the North American B-70 program (AW Nov. 14, p. 37) will add substantially to the company's defense work schedules, particularly in the area of brazed stainless honeycomb sandwich structures. Rohr contracts call for manufacture of wing components and fuselage bulkheads for the Mach 3 aircraft.

Northrop Corp. reports a net income for the three months ended Oct. 30 of $2,042,000, compared with earnings of $1,463,000 for the first quarter of last year. Sales in the first quarter of this year amounted to $62,028,000. First quarter sales in 1959 were $55,873,000.

Emerson Electric Manufacturing Co., St. Louis, Mo., had sales of $125,468,111 for Fiscal 1960. Earnings for the year were $6,000,310. Sales and earning for Fiscal 1959 were $91,332,950 and $3,938,717 respectively.

The Budd Co.'s Canadian subsidiary has changed its name from Tatnall Measuring and Nuclear Systems, Ltd., to Budd Instruments, Ltd. The Canadian firm has also moved its offices from Toronto to Don Mills, Ontario. Budd Instruments, Ltd., makes strain gages, digital strain indicators, switch and balance units, radiography equipment, eddy current testing equipment and magnetic particle testing equipment.

Piper Aircraft Corp. reported sales increased 17% and earnings 26.6% in its 1960 fiscal year ended Sept. 30. Sales figures were $40,212,000 compared with $34,263,000 in 1959 and earnings were $3,523,000 or $3.50 a share as against $2,782,000 or $3 a share the previous year. Piper expects lower earnings next year, partly because of production start costs at Vero Beach, Fla., on the all-metal four-place Cherokee.

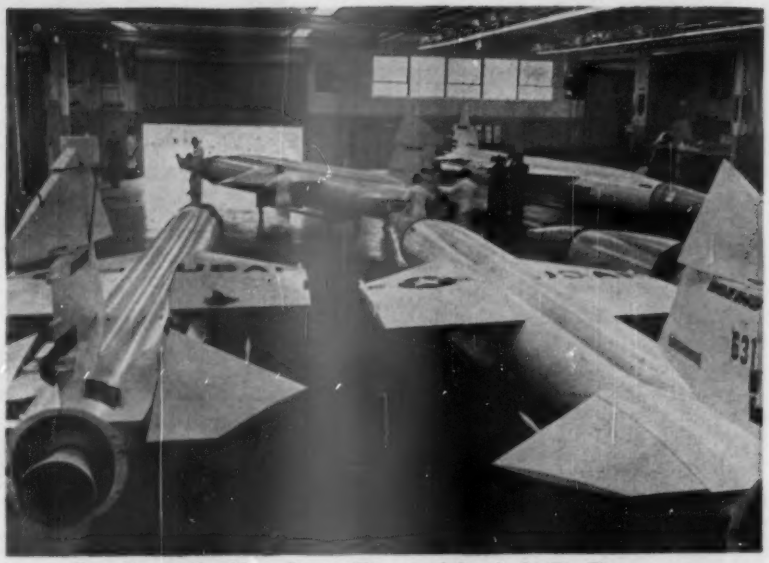
Servomechanisms, Inc., El Segundo, Calif., reports net sales of $10,196,000 for the first nine months of 1960 ended Sept. 30. After writing off $682,000 in new product development costs, the company had a net loss of $771,000. Sales for the first nine months of 1959 were $10,816,000; net loss was $246,000.

New Offerings

National Aeronautical Corp., Ft. Washington, Pa., engaged in developing, manufacturing and selling radio communication and navigation equipment for civilian airplanes; Air-Shields, Inc., a subsidiary acquired in August, 1960, is engaged in the development, manufacture and sale of specialized medical equipment. Offering is 60,000 shares of common stock for public sale; offering price and underwriting terms to be supplied by amendment. Proceeds will be used to prepay all mortgages on the plants of the two companies (aggregating some $260,000); to prepay all bank loans (amounting to $446,250 on Aug. 31); $300,000 to construct an addition to Air-Shields' manufacturing plant, including enlarged facilities for laboratories and offices; the balance for working capital.

Lake Central Airlines, Inc., Indianapolis, Ind., engaged in the transportation by air of passengers, property and mail now servicing 33 cities through 29 airports in Indiana, Ohio, Michigan, Illinois, Pennsylvania and New York. (It is anticipated that the company will be authorized to extend its services into Washington and Baltimore, adding 15 new cities to its system.) Offering is 130,000 shares of $20 par convertible preferred stock for public sale; offering price and underwriting terms to be supplied by amendment. Proceeds from the sale of the preferred stock and $3,000,000 from an equipment loan from The Indiana National Bank of Indianapolis will be used as follows: $1,905,000 for the purchase of five Convair 340 aircraft, including modification and spare parts (the balance due on the purchase price of $2,850,000); $800,000 for the purchase of 10 DC-3 aircraft, including modification and spare parts; $350,000 for the purchase of ground equipment; $250,000 for pre-operating and training expense in connection with new aircraft and additional service facilities; $500,000 for the repayment of an outstanding mortgage note; $845,000 for the repayment of outstanding interim equipment notes; $650,000 for additional working capital.

Loral Electronics Corp., New York, N. Y., primarily engaged in the research, development and production of electronic equipment for military use. Offering is $5,000,000 of convertible subordinated debentures, due December, 1980, for public sale; interest rate, offering price and underwriting terms to be supplied by amendment. Of the proceeds, $2,000,000 will be used to defray the cost of additions to plant, equipment and other facilities, of which about $1,000,000 will be used in connection with the company's commercial operations; the balance to be used in whole or in part to acquire the stock or assets of other businesses if suitable opportunities arise for such purchase, or to meet the working capital requirements arising from any such acquisition. Any proceeds not so used will be used to meet expected increased requirements arising from the growth of the company's business, for working capital to carry a greater volume of receivables and inventories.



Boeing Rolls Out First Model B Bomarc

First Model B Bomarc air defense missile rolls out of Boeing Airplane Co.'s factory at Seattle. The B version has a solid-propellant booster replacing the liquid-propellant booster of the Bomarc A. Bomarc B range is 400 mi., compared with 200 mi. for the Bomarc A. Bomarc Bs will become operational next summer at Niagara, N. Y.

Rohm & Haas Co., Philadelphia, Pa., manufacturers of chemicals for industry (Plexiglas for aviation). Offering is 9,000 outstanding shares of common stock for public sale by the executors of the estate of Otto Haas, former board chairman and president; offering price and underwriting terms to be supplied by amendment.

The Siegler Corp., Los Angeles, Calif., engaged in the manufacturing of military electronics, commercial and industrial electronics, heating and cooling, aero-space components and specialized machinery. Offering is 410,000 shares of common stock and 105,000 shares of no par cumulative convertible preferred stock, to be offered to stockholders of Jack & Heintz, Inc., upon consummation of a proposed merger of Jack & Heintz into Siegler, if such merger is approved by stockholders of both companies. The stockholders of Jack & Heintz will receive common shares of Siegler at the rate of 0.55 shares of Siegler stock for each outstanding share of Jack & Heintz common unless, in lieu of common stock, they elect to receive shares of preferred stock of Siegler. The rate of exchange of the Siegler preferred stock for the Jack & Heintz common stock is to be supplied by amendment.

Jack & Heintz is engaged primarily in the design, development and manufacture of electric power generating systems and equipment and accessory and support equipment for military and commercial aircraft, ordnance vehicles and missiles and related ground support equipment.

International Electronic Research Corp., Burbank, Calif., which was incorporated under California law in 1953, has developed and manufactures an accessory for use with electron tubes known as a heat-dissipating tube shield. In addition, it operates a precision machining facility doing subcontract work in the aircraft and rocket engine industry, and manufactures certain precision a. c. instruments. Offering is 220,000 shares of common stock; 110,000 shares to be offered for public sale by the company, and 110,000 outstanding shares by the present holders thereof. Public offering price and underwriting terms to be supplied by amendment. Proceeds from the sale of additional stock will be used to repay bank loans, outstanding as at Dec. 1, 1960, in an amount of $124,000; to pay the balance due, $430,125, in connection with the company's purchase of assets of Millrich Industries, Inc.; to pay the $13,432 balance due on equipment purchase contracts; the remainder to increase working capital.

FLAT nacelles designed for the Continental IO-470-L fuel injection engines on the Beech Baron twin are 78 in. wide.

Aviation Week Pilot Report:

Beech Enters Baron in Light Twin Market

By Herbert J. Coleman

Wichita, Kan.—Beech Aircraft Corp. has filled a gap in its product line with development of the new Model 55 Baron light twin, designed for a high degree of safety, a maximum of speed and performance and an eye on competitive aircraft.

The Baron (AW Nov. 21, p. 31) spans the so-called product gap between the Beech Travel Air and the Twin Bonanza, according to V. L. Gaston, manager of Baron and Travel Air Sales, as part of Beech's continuing development program.

But the Baron, a five place plane which sells for $58,250, is pitted in the business plane market—dominated particularly by owner-operated aircraft—against the Piper Aztec ($52,990) and the Cessna 310 ($62,500), both popular airplanes with a marked impact on over-all sales that are estimated at $70 million in 1961-62.

The new Beech already has had a strong impact on production in the Wichita plant. So far, 30 planes have been built and Beech is working on a revised production schedule increasing the original plan for 125 planes in 1961.

Beech is building the Baron on about a one-a-day basis at present, according to Paul H. Edwards, assistant manager of Beech Plant No. 2 where the Baron is mixed on one production line with Travel Airs. Thirty Barons have been rolled out so far.

On a nearby line, which produces a complete airplane ready for flight test every 3 hr. 20 min., is the single-engine Debonair. Edwards, backed by other Beech executives, says the Baron will go out almost as fast whenever orders warrant. The company now has orders for the 125 airplanes it planned to build and top company officials admit that figure was conservative, "as it would be with any new airplane."

These orders mostly are for domestic delivery. But Beech has high hopes for the Baron overseas and has one airplane now in Germany at Travel Air GmbH., Bremen, for demonstration, with four more headed that way soon.

R. E. Staggs, assistant manager of export-military-fleet sales, said foreign orders now total 20. He is strongly concerned with getting demonstrators in key areas, such as South America, Mexico, Canada and Japan.

The demonstrator for Japan will be flown there to C. Itoh & Co., Ltd., Tokyo, by Leo Sanders, company service representative, via a varied trip through central Europe, Italy and the Far East. Sanders will make a service tour—with an inevitable sales pitch—on his way to Tokyo.

First Baron to South America goes to Will S. Smith, S. A., of Buenos Aires, Argentina, and the next to Aeromex S. A. de C. V., Chihuahua, Mexico. Others, as they become available, will be flown to the Philippines, Venezuela, Uruguay and Canada. Three are sched-

SWEPT tail is dominant design feature of the new Beech Baron twin, now in production.

uled for Transair S. A., which handles distribution in Switzerland, France, Italy and Austria.

Basically, the plane is a follow-on to the Travel Air, in that it utilizes prime components such as the cabin, wing and landing gear. Big change is in enlarged seating and baggage capacity, a swept tail one-third larger than the Travel Air's and two Lycoming IO-470-L 260 hp. fuel injection engines, horizontally opposed and encased in flat nacelles jutting well ahead of the pilot's compartment. Nose compartment has been streamlined to include an additional baggage compartment, the battery and radio gear, and rear windows have been enlarged to provide excellent visibility for passengers and almost 180-deg. capability for the pilots.

It has been designed for—and flown in—high load factor conditions, according to M. J. Gordon, manager-commercial engineering, who noted that the Baron has been certificated for penetration speeds of 194 mph. through turbulence of 45 fps. In addition, Gordon said, control system has been improved for smoother, more precise handling and a dorsal fin has been added to increase strength and stability of the enlarged vertical tail section.

To evaluate the Baron, this AVIATION WEEK pilot flew the airplane with Warren F. Filer, assistant manager-flight operations, on a 36F day with moderate winds. Plane carried half its fuel load of 140 gal. (39 gal. in each of two main tanks and 31 gal. in each of two auxiliary tanks) since it had been flown steadily during the morning period for visiting dealers.

The Baron has a gross weight of 4,880 lb. and a useful load of 1,920 lb. It can carry five persons and their luggage (270 lb.) over a 1,000 mi. range at 216 mph. at 65% cruise power. Beech claims. Top speed is 230 mph.

In general, the flight evaluation showed that the Baron in most cases slightly exceeds its published figures. Gordon said the Baron went through a complete Federal Aviation Agency certification program and this was followed by Beech's own flight test program, despite the fact that the aircraft utilizes many Travel Air components.

The Baron is a sturdy, but sleek-looking plane which is roomy yet compact. Entry is made from the left side and there is ample room for pilots, since the seats have a long travel. Baron flown was N 9335Y.

Starting sequence is simple and differs little from that of other twins, except that Beech has revised the magneto system to incorporate separate switches for left and right mags on both engines. Each engine has its own starter button.

The Baron is easy to taxi and has a

PROTOTYPE Baron has tufted wings for flight testing at Beech's Wichita plant.

FIFTH seat installed in Baron cabin mockup is optional. Note rear baggage shelf above. Cabin configuration of the Baron is derived from Beech Travel Air cabin design. Baggage also is carried in the nose section of the Baron.

NOSE wheel is adapted from Travel Air; gear is stressed for 600 fps.

tight turn radius. Propellers were run through at 2,200 rpm. and mags checked at 1,700 rpm. for a 50 rpm. maximum drop.

Takeoff Run

Takeoff run was remarkably short, even considering that N 9335Y was comparatively light, some radio gear not having been installed, and that it was a 36F day with a 20 kt. wind from the southwest. We were off the ground in about 1,000 ft. climbing at 140 mph., a speed which produced a climb rate of 2,000 fpm.

To show the Baron's climb capability, Filer suggested a maximum climb angle; using caution, we put the Baron in a 45 deg. climb until speed dropped to just under 90 mph. This produced a 3,500 fpm. climb rate, still using takeoff power of full throttle and 2,500 rpm.

Climb Rate

Climb rate is one of the Baron's strong features. On this flight, it took about 5 min. to reach 7,500 ft. Beech performance tables call for a climb to 12,500 ft. in 12 min.

Even though the Baron's climb is excellent, it is the ease and smoothness of transition to level cruise speeds that is impressive. After leveling off at 7,500 ft., speed quickly built up from 140 mph. to an indicated 208 mph., using 22.5 in. of manifold pressure and 2,400 rpm. This trued out to about 220 mph.

The Baron, with its high cruise speed and good visibility, will be a good cross-country airplane. New back window allows for about 330 deg. of visibility from the pilot's seat; nearly all of both horizontal stabilizers can be seen. Pilot's windshield has considerable depth for forward visibility, both up and down.

Over-all, the Baron has fighter-like handling capability, in that responses to control pressures are quick and light. For demonstration purposes, Filer put the Baron in a 90 deg. bank, indicating 190 mph., and then rolled it through the axis to the opposite 90 deg. without losing altitude or airspeed. Control action was smooth throughout. For normal category purposes, however, only 60 deg. maximum banks are permitted.

Stall Phase

In the flight safety regime, the Baron shows up well in stalls, both clean, power on and off, and single engine. In

Baron Specifications

Dimensions	
Wing span	37 ft. 10 in.
Length	25 ft. 8 in.
Height	9 ft. 7 in.
Cabin length	8 ft. 6 in.
Cabin width	3 ft. 6 in.
Cabin height	4 ft. 2 in.
Passenger door, size	36 in. x 37 in.
Baggage door, size	18½ in. x 22½ in.
Weights	
Gross weight	4,880 lb.
Empty weight	2,960 lb.
(Empty weight includes complete set of flight instruments; cabin heating and ventilating system, with windshield defrosting; sound proofing; navigation, cabin, instrument and landing lights.)	
Useful load	1,920 lb.
Available weight for people and baggage with standard fuel tanks full	1,191 lb.
Wing Area, Loadings	
Wing Area	199.2 sq. ft.
Wing Loading, at gross weight	24.5 lb./sq. ft.
Power Loading, at gross weight	9.4 lb./hp
Fuel, Oil Capacity	
Standard fuel arrangement (Includes two main tanks, 25 gal. each, and two auxiliary tanks, 31 gal. each)	112 gal.
Optional fuel arrangement (Includes two main tanks, 39 gal. each, and two auxiliary tanks, 31 gal. each)	140 gal.
Oil capacity	6 gal.

PROBLEMATICAL RECREATIONS 46

A hunter wished to take his one-piece rifle on a train but the conductor refused to permit it in the coach and the baggage man could not take any article whose greatest dimension exceeded 1 yard. The length of the rifle was 1.7 yards. What could the hunter do?

Current developmental work in our Guidance Systems Laboratory includes gas spin bearing gyros, an astro-inertial navigation system, and miniature inertial platforms.

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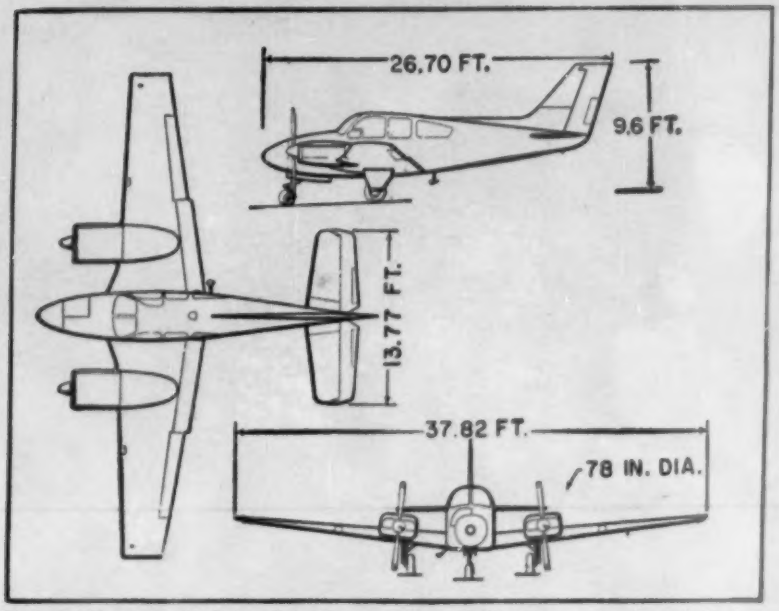

SWEPT tail was newly designed for Baron and is one-third larger than Travel Air tail.

the power-on phase, in clean configuration, the Baron stalled with a shudder that gave ample warning—plane has a stall warning light and buzzer—at about 50 mph. indicated. Published figure at full gross is 67 mph.

Nose dropped straight through the horizon and speed quickly returned to the 200-plus indication, when we feathered the right engine by reducing the throttle and mixture controls to full-feather and idle-cutoff detent positions.

This routine was flown at 65% power throughout. Flying straight and level, feeding in necessary trim, the speed fell off to 140 mph. and stabilized there. At maximum power, with cowl flap open, Baron climbed at about 300 fpm. before it was stalled with power off.

This time, the nose dropped sharply and the Baron turned into the dead engine. But with hands off the controls, the nose gradually lifted in the spiral and took on a fairly gentle glide, with speed building to 140-150 mph.

In another single-engine, power-off stall, Baron was put into a 30 deg. bank into the operating engine, nose lifted and then forced into a stall regime. The plane shuddered but continued its

Baron Model 55 Operating Costs

	400 Hr. 80,000 Miles/Year	500 Hr. 100,000 Miles/Year	600 Hr. 120,000 Miles/Year	700 Hr. 140,000 Miles/Year
Cost Per Hour (Direct Operating Costs)				
(1) Gasoline	$10.53	$10.53	$10.53	$10.53
(2) Oil	.66	.66	.66	.66
(3) Inspection, maintenance and propeller overhaul	3.50	3.50	3.50	3.50
(4) Engine overhaul allowance	3.78	3.78	3.78	3.78
Total direct operating cost per hour	**$18.47**	**$18.47**	**$18.47**	**$18.47**
Indirect Operating Costs				
(5) Hangar rental	2.75	2.30	2.00	1.79
(6) Insurance	3.36	2.69	2.24	1.92
Total indirect operating cost per hour	**$ 6.11**	**$ 4.99**	**$ 4.24**	**$ 3.71**
Total operating cost per hour	**$24.58**	**$23.46**	**$22.71**	**$22.18**
Cost Per Mile				
(7) Operating cost per mile	12.3¢	11.7¢	11.4¢	11.1¢
(8) Depreciation allowance for tax purposes	11.7¢	9.3¢	7.8¢	6.7¢
(9) Total cost per airplane mile	24.0¢	21.0¢	19.2¢	17.8¢
(10) Total cost per seat mile (5 seats)	4.8¢	4.2¢	3.8¢	3.6¢

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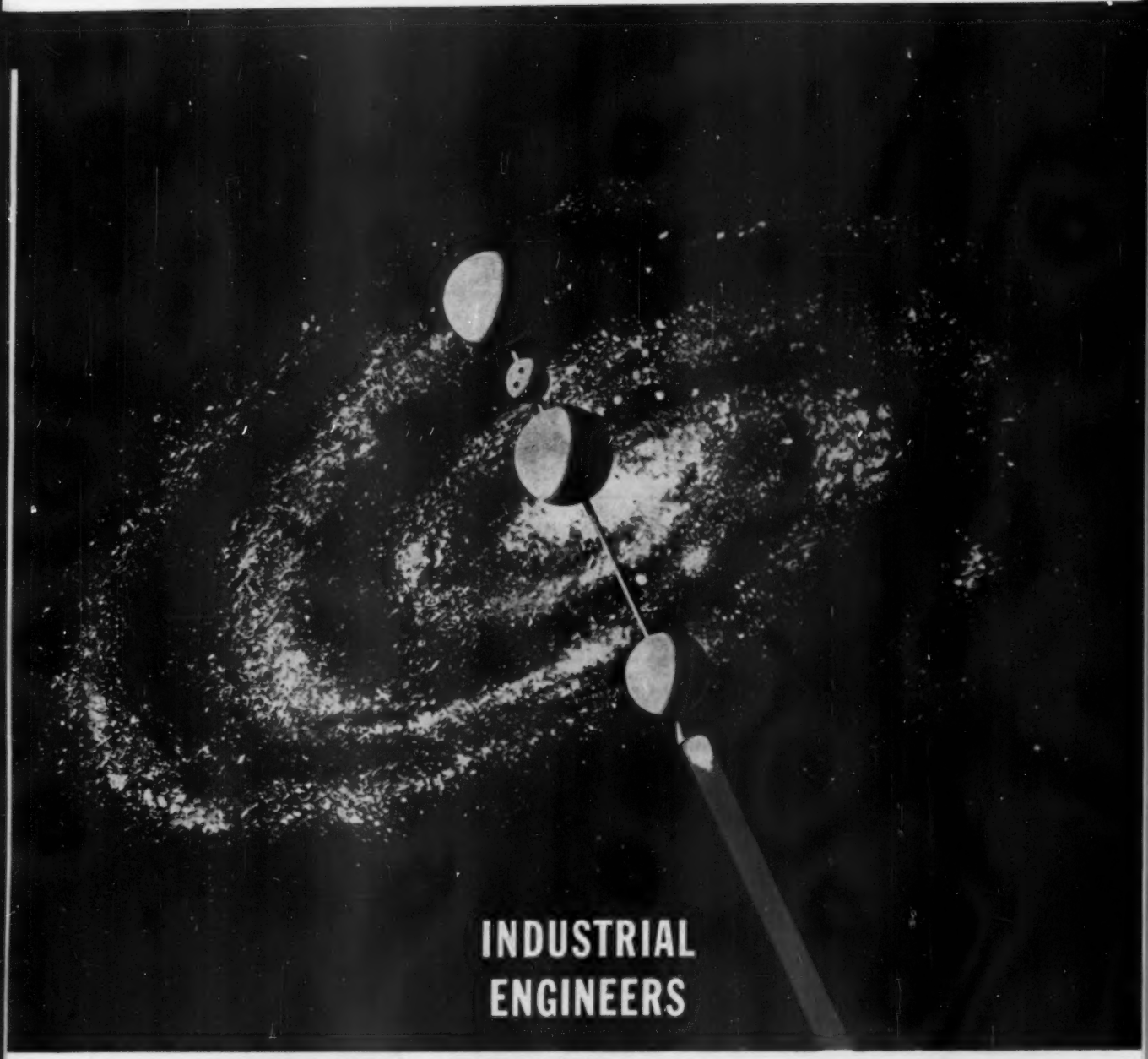

Artist's conception of fusion-photon intergalactic space vehicle

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turn under full control, even though the ailerons were deliberately aggravated by sharp movements at this time. Again, the Baron was rolled to straight and level flight and the speed again built up to a bit less than 140 mph., still using only 65% power on the left engine.

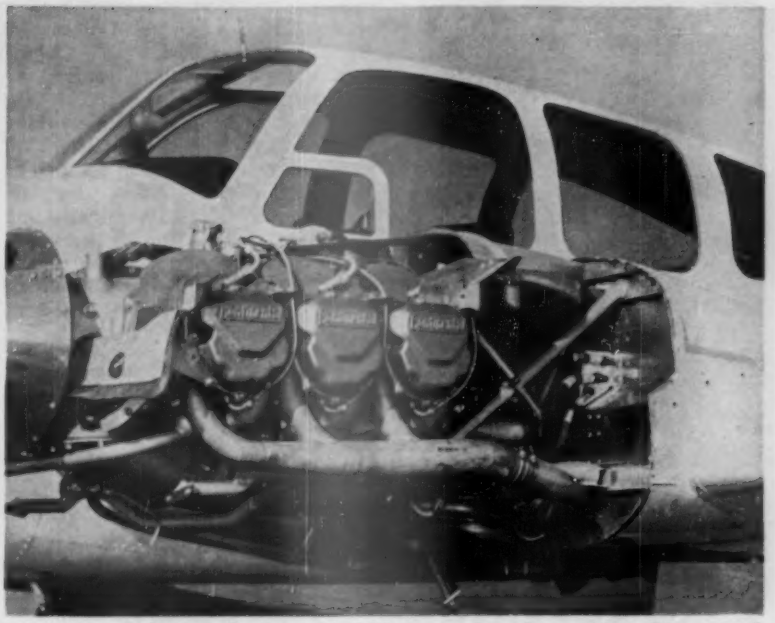
With this high degree of performance, the built-in safety factor is obvious. Another is the let-down performance for instrument flight; with power off, the Baron will let down at 90 mph. after trimming it for a 500 fpm. descent. This maneuver also is accomplished hands-off, if desired.

Entering traffic at Wichita for landing, gear was dropped at 140 mph. on the downwind leg. No flaps were used until turning onto the final approach, when full flaps were dropped at 120 mph. and a final approach speed of 110 mph. was established. Flareout was made at about 90 mph., about 10 mph. faster than necessary, and plane touched down on the first third of the runway. Roll was short and plane could have been stopped much sooner with slower approach and use of brakes.

In the production phase, many of the Baron parts, such as struts, are fabricated in Beech Plant No. 1 and then trucked to Plant No. 2 across the field for final assembly.

Nose and tail cones are made of plastic in a Plant No. 2 section. In addition, this department manufactures the rear window frame out of U. S. Rubber Co. Royalite. The company also manufactures its own foam rubber for seats and has a large department set up for design, cutting and installation of foam rubber and a wide array of seat fabrics.

Control system was modified from the Travel Air system, Edwards noted. Primary controls are operated through



BARON'S powerplants are Continental fuel injection engines, shown with cowling removed.

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push-pull rods and conventional cable systems which terminate in bellcranks. Cables run over phenolic pulleys which have sealed ball bearings requiring no lubrication.

Trim tabs are adjustable from the lower center console; left aileron tab incorporates servo action in addition to trimming functions. Flaps, which are operated through flexible shafts and jack-screw actuators, are of the single, slot type and are driven by an electric motor under the front seat. They extend to a 28 deg. full-down travel; limit switches automatically shut off the flap motor when full up or down travel is reached.

Fuel system has separate, identical supply for each engine, connected by cross-feed for emergency use. Fuel selector controls the cells, and gages are on center main console. Individual boost pumps furnish pressure for starting.

Oil system is of full-pressure, wet sump type with a 12 qt. capacity. Temperatures are controlled by an automatic thermostat bypass control in the oil passage of each system. This prevents oil flow through the cooler when operating temperatures drop below normal.

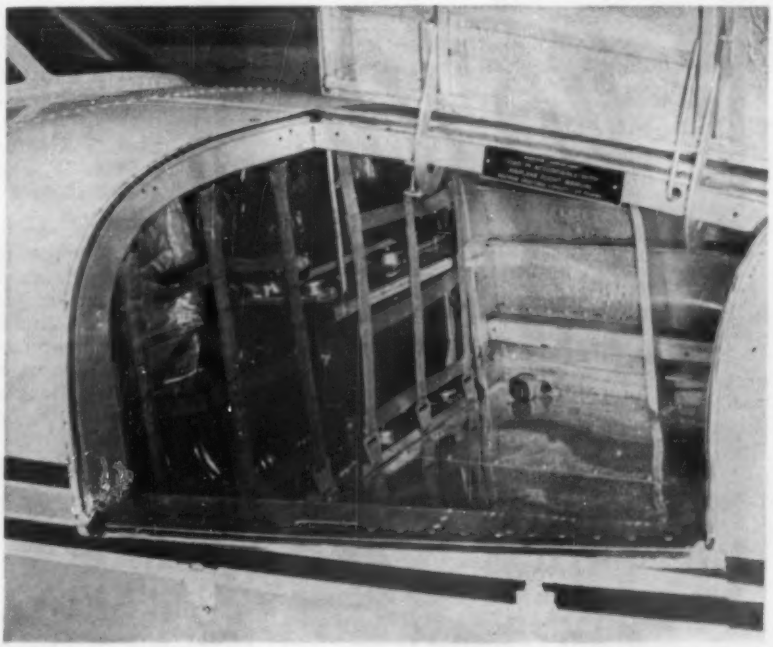
Electrical system is direct current, 24-v. with battery mounted in lower section of nose compartment, and two 25-amp. belt-driven generators connected in parallel. Cabin heat comes from a 50,000 Btu. Janitrol heater mounted in the nose cone.

Emergency provision for lowering the landing gear involves a hand crank in the forward center section of the pilot's compartment, allowing gear extension, in extreme conditions, up to 200 mph.

Evaluation did not include a fuel consumption check but Beech says that the Baron will use about 31 gph. at 75% hp., a regime producing about 196 hp. from each engine. For a lean fuel condition, consumption at that power setting for level flight will be about 27.5 gph.

Baron Performance

Cruising Speeds	
(a) At 75% power (2450 rpm) at 7,000 ft.	220 mph
(b) At 65% power (2450 rpm) at 10,300 ft.	216 mph
High Speed at Sea Level (2625 rpm, full throttle)	230 mph
Range (Includes full allowance for fuel used during warm-up, taxi, take-off and climb to altitude with a 45-min. fuel reserve at maximum-range speed)	1,220 mi.
Rate of Climb at Sea Level (Rated Power)	
Two engines at 4,880 lb.	1,630 fpm
Single engine at 4,880 lb.	305 fpm
at 4,500 lb.	430 fpm
at 4,000 lb.	620 fpm
Service Ceiling (Rated Power)	
Two engines at 4,880 lb.	19,200 ft.
Single engine at 4,880 lb.	6,800 ft.
at 4,500 lb.	9,800 ft.
at 4,000 lb.	14,500 ft.
Absolute Ceiling	
Two engines at 4,880 lb.	20,400 ft.
Single engine at 4,880 lb.	8,100 ft.
at 4,500 lb.	11,100 ft.
at 4,000 lb.	15,800 ft.
Stall Speed (zero thrust), Flaps 28 deg., Gear Down	76 mph
Take Off Distance (20 deg. Flaps)	
Ground Run	910 ft.
Total distance over 50 ft. (At sea level, zero wind, standard temperature)	1,255 ft.
Landing Distance (28 deg. Flaps)	
Ground Run	1,175 ft.
Total distance over 50 ft. (At sea level, zero wind, standard temperature)	1,750 ft.



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LETTERS

Bird Hazard

While reading about the dent in the air scoop (AW Oct. 31, p. 40) I am reminded of the time I flew through a flock of small birds in England during the war. I had reduced throttle in a P-51 so I could slow down and lower the wheels when I saw a flock of birds ahead. The visibility was about a half mile and when I saw the birds I was so close to them that I had to pull up rather sharply—right into another flock above and beyond the first. My airspeed had dropped to 200 mph. and I hit about a dozen of the birds. The airplane shook and each impact felt and sounded as if I had hit a brick. After landing I found dents in the leading edge as big as a fist and an inch deep. Considering the thickness of a P-51 leading edge it took terrific impact to make the dents. An English pilot told me that the birds were ptarmigan.

Incidentally, the starlings on the Boston runway probably were descendants of the 100 European birds introduced into Central Park in 1890.

Clay Steffee
Kissimmee, Fla.

GSE Specifications

Just finished reading your fine article titled "Ground Equipment Costs Show Steady Rise," Oct. 24 issue, p. 32.

Maj. Gen. Austin Davis and Lt. Gen. Bernard A. Schriever obviously don't understand the problem at hand when they indicate that industry is trying "to evade" compliance with dear old MIL-D-9412C (and amendments thereto). Which party or group can understand this specification? WADD, AIA, and AF Bulletin #517 (dated May 18, 1960) have presented interpretations—but they don't agree with each other. So, how can one branch of industry make a proper interpretation of this mumbo-jumbo document when leaders of industry themselves can't do it?

Gen. Davis, I ask you very simply, just what are the specific requirements you want industry to give your Command as a result of the intent of MIL-D-9412?

It is the general consensus that this document requires a maintenance analysis be accomplished on a weapon system in order to determine the GSE requirements. If this is a true interpretation (and I know of no other document stating otherwise), what do you want contained within the body of the maintenance analysis? I recognize that other MIL Specs exist that require other pieces of information above and beyond justification for GSE requirements and, therefore, should (I believe) also be made a part of the maintenance analysis requirements. Items such as GSE spares, weapon system spares, maintenance requirements, design monitoring, et cetera, are all but a small part of a maintenance analysis, however, MIL-D-9412 does not call these items out, yet this Spec does establish the analysis requirements. In view of this it would seem highly practical that a MIL Spec should be designed to delineate the requirements for a maintenance analysis program in direct reference to all aspects of support for a weapon system, rather than piecemeal in a dozen different MIL Specifications. It is also suggested that a chronological sequence be established when levying commitments on contractors to fulfill specification requirements. So what if the specification is a little longer—at least it should be clear without question what is meant. The weapon systems are getting to be more complicated, but I don't see any reason for the complication of directions to be followed when mere information is required.

I understand that a "D" revision is to be released for MIL-D-9412. I can only hope that this revision will clarify what all previous ones have failed to do—clearly state your requirements! Amen.

This is my first letter to the "Wet Handkerchief Department" of Aviation Week, so I might as well add this note by saying that other existing MIL Specifications should be viewed with an eye toward revisions for clarification, for it goes without saying "If we lose communicative contact with each other then we lose peace with each other."

Frustrated Engineer
San Pedro, Calif.

Aviation Week welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W. 42nd St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

Industry Stability

Your editorial of Nov. 14, "Supersonic Transport Race," is very appropriate coming just after the political campaign has ushered in a Democratic administration. You covered the subject very well, but I feel there is one other point that is very important to this subject and all of aviation and its related industries.

Higher costs and inflation usually follow any accelerated program that is government sponsored. This in turn limits the program. Now that most of the groups representing employes are friendly toward the new administration, they could take this problem as their number one responsibility in conjunction with the employers.

Assume that the aviation industry employers and employes would sign a 10-year contract to maintain present basic wage rates, and yearly contracts to cover other items. This would give the industry stability that would make long-range planning more realistic, provide means for reducing costs, and provide a definite plan for increased production at lower costs to meet foreign competition. More jobs would be available and with less uncertainty. In fact our entire economy would change; our foreign friends would not hesitate to joint us rather than our enemies. You and I would go out and buy that second car, those new appliances, that new furniture, and many other things we have been needing so long.

The first employer-employe group to establish such a long-range working plan will surely start the trend that will save these United States from disaster of its own making. I would like to see the aviation industry accept this challenge, and make sure that the first "supersonic transport" carries the red, white and blue of the U.S.A. How about hearing some comments from employer and employe groups on such a plan? I am sure Aviation Week will give your letters adequate space.

Harry G. Bangerter
Whittier, Calif.

Minuteman Bases

What is the rationale of rushing the construction of the Minuteman bases in Montana (AW Nov. 7, pp. 71-77), under the most difficult and expensive construction conditions possible, when the missile has not once been flight tested and is very unlikely to reach operational status until well after the completion date of at least the first several base flights?

Is there a real need for the schedule to call for nearly all of the base flights to be started under winter conditions and proceed on crash basis, or would the program to make the missile operational suffer by virtue of later completion dates for the earlier bases?

Is it possible that the Corps of Engineers' Ballistic Missile Construction Office, worried about base construction slippage in other programs, has placed unnecessarily stringent demands on the potential contractor and backed them up with slippage fines in order to show just how tough the Office can be?

It seems to me, an engineer not connected in any way with base construction, that potential contractors will submit very high bids for the Minuteman base job to protect themselves from the big whip wielded by the BMCO. If this is merely an example of the old Army game of "hurry up and wait," the nation will be paying a high price for the exercise.

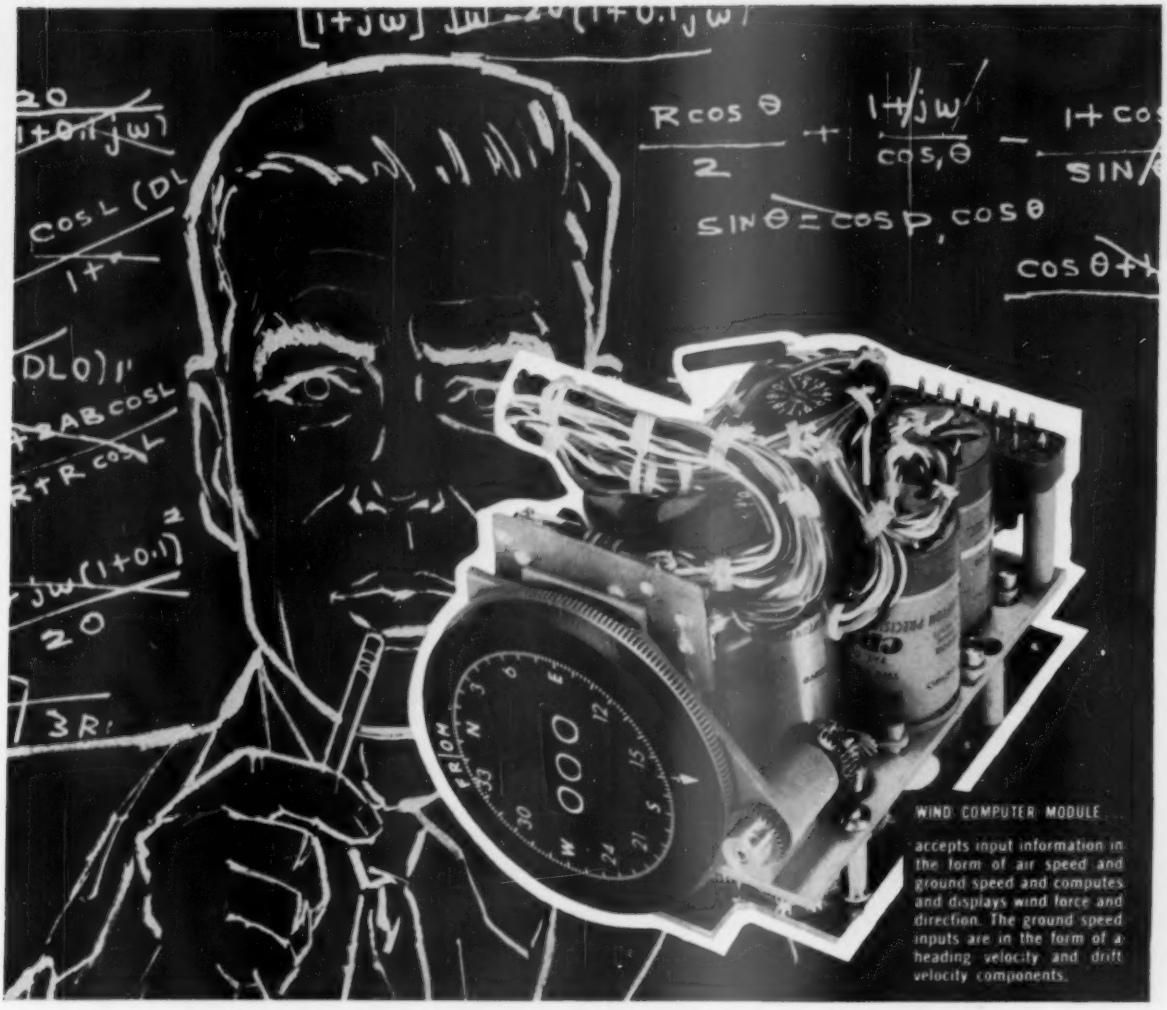
Frank R. Heath
Pittsburgh, Pa.

GV-1 Wing Pods

I would like to call your attention to an error in your Nov. 14 issue (p. 33). The picture of "Production JetStars Readied for Flight Tests" contains a United States Marine Corps Model GV-1 airplane in the left background and not a "C-130 Hercules with long-range fuel tanks under wings." The under wing pods of the GV-1 contain the hoses and reels for the air refueling (AR) system. The airplane in the photograph is probably GV-1 BuNo 147573 or Lockheed Number 3555. Immediately behind the GV-1 is a Douglas A4D-2N which is bailed to Lockheed for development work in connection with the AR system.

Capt. Robert E. Solliday, USMC
Naval Air Test Center
U. S. Naval Air Station
Patuxent River, Md.

(Capt. Solliday is correct.—Ed.)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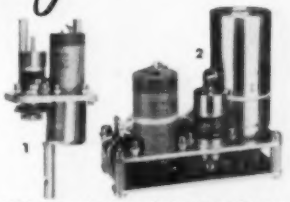

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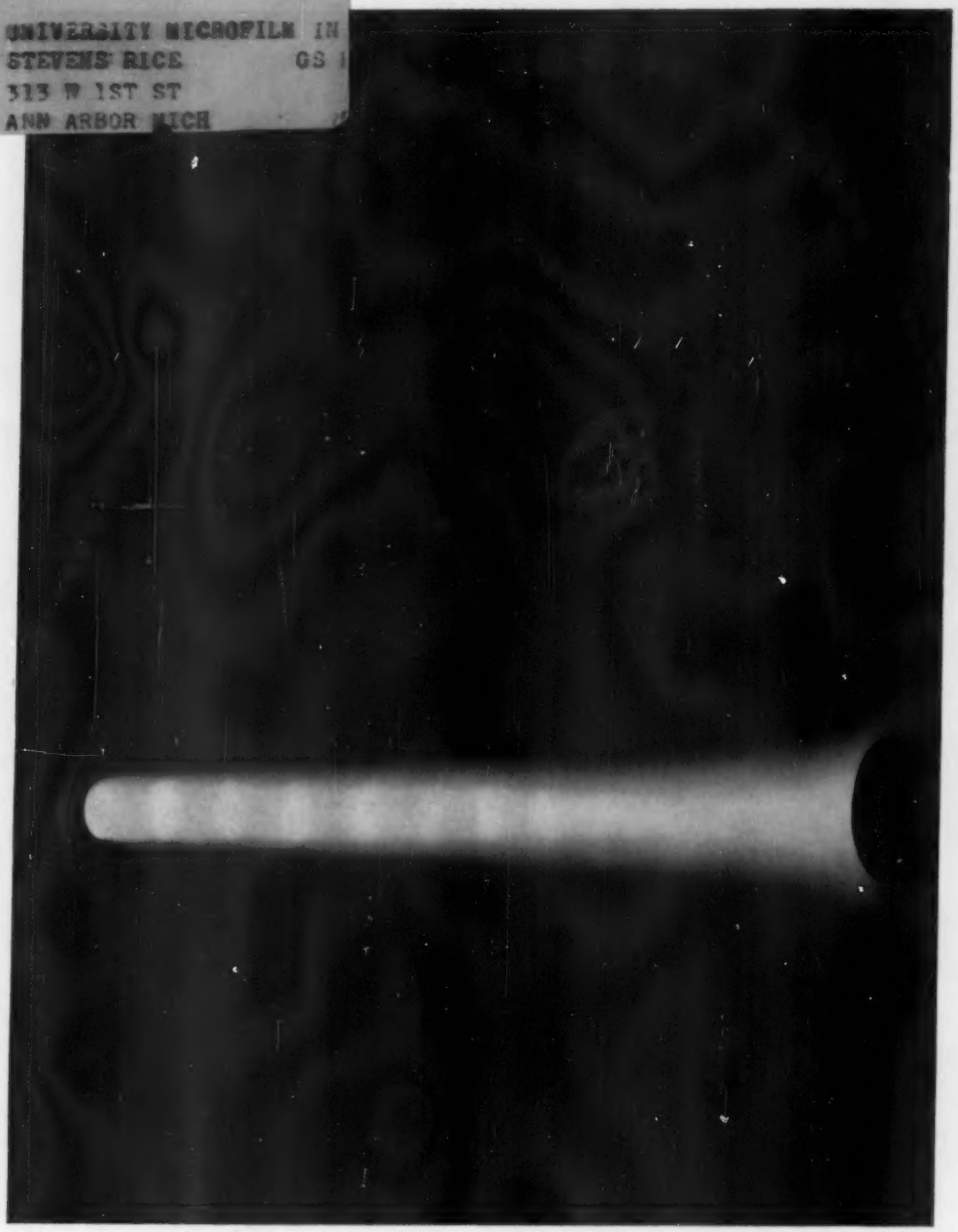

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